ENCYCLOPÆDIA BRITANNICA;

OR, A

DICTIONARY

OF

ARTS, SCIENCES,

AND

MISCELLANEOUS LITERATURE;

Conſtructed on a PLAN,

BY WHICH

THE DIFFERENT SCIENCES AND ARTS

Are digeſted into the FORM of Diſtinct

TREATISES OR SYSTEMS,

COMPREHENDING

The HISTORY, THEORY, and PRACTICE, of each,
according to the Lateſt Diſcoveries and Improvements;

AND FULL EXPLANATIONS GIVEN OF THE

VARIOUS DETACHED PARTS OF KNOWLEDGE,

WHETHER RELATING TO

NATURAL and ARTIFICIAL Objects, or to Matters ECCLESIASTICAL,
CIVIL, MILITARY, COMMERCIAL, &c.

Including ELUCIDATIONS of the moſt important Topics relative to RELIGION, MORALS,
MANNERS, and the OECONOMY of LIFE:

TOGETHER WITH

A DESCRIPTION of all the Countries, Cities, principal Mountains, Seas, Rivers, &c.
throughout the WORLD;

A General HISTORY, *Ancient* and *Modern*, of the different Empires, Kingdoms, and States;

AND

An Account of the LIVES of the moſt Eminent Perſons in every Nation,
from the earlieſt ages down to the preſent times.

Compiled from the writings of the beſt Authors, in ſeveral languages; the moſt approved Dictionaries, as well of general ſcience as of its particular branches; the Tranſactions, Journals, and Memoirs, of Learned Societies, both at home and abroad; the MS. Lectures of Eminent Profeſſors on different ſciences; and a variety of Original Materials, furniſhed by an Extenſive Correſpondence.

THE THIRD EDITION, IN EIGHTEEN VOLUMES, GREATLY IMPROVED.

ILLUSTRATED WITH FIVE HUNDRED AND FORTY-TWO COPPERPLATES.

VOL. XV.

INDOCTI DISCANT, ET AMENT MEMINISSE PERITI.

EDINBURGH,
PRINTED FOR A. BELL AND C. MACFARQUHAR.
MDCCXCVII.

ENCYCLOPÆDIA BRITANNICA.

Plant. PLANT is defined to be, an organical body, deſtitute of ſenſe and ſpontaneous motion, adhering to another body in ſuch a manner as to draw from it its nouriſhment, and having a power of propagating itſelf by ſeeds.

The vegetation and economy of plants is one of thoſe ſubjects in which our knowledge is extremely circumſcribed. A total inattention to the ſtructure and economy of plants is the chief reaſon of the ſmall progreſs that has been made in the principles of vegetation, and of the inſtability and fluctuation of our theories concerning it; for which reaſon we ſhall give a ſhort deſcription of the ſtructure of plants, beginning with the ſeed, and tracing its progreſs and evolution to a ſtate of maturity.

1. *Of Seeds.*] The ſeeds of plants are of various figures and ſizes. Moſt of them are divided into two lobes; though ſome, as thoſe of the creſs-kind, have ſix; and others, as the grains of corn, are not divided, but entire.

But as the eſſential properties of all ſeeds are the ſame, when conſidered with regard to the principles of vegetation, our particular deſcriptions ſhall be limited to one ſeed, viz. the great garden-bean. Neither is the choice of this ſeed altogether arbitrary; for, after it begins to vegetate, its parts are more conſpicuous than many others, and conſequently better calculated for inveſtigation.

This ſeed is covered with two coats or membranes. The outer coat is extremely thin, and full of pores; but may be eaſily ſeparated from the inner one (which is much thicker), after the bean has been boiled, or lain a few days in the ſoil. At the thick end of the bean there is a ſmall hole viſible to the naked eye, immediately over the radicle or future root, that it may have a free paſſage into the ſoil (fig. 1. A). When theſe coats are taken off, the body of the ſeed appears, which is divided into two ſmooth portions or lobes. The ſmoothneſs of the lobes is owing to a thin film or cuticle with which they are covered.

Plate CCCXCIV.

At the baſis of the bean is placed the radicle or future root (fig. 3. A). The trunk of the radicle, juſt as it enters into the body of the ſeed, divides into two capital branches, one of which is inſerted into each lobe, and ſends off ſmaller ones in all directions through the whole ſubſtance of the lobes (fig. 4. AA). Theſe ramifications become ſo extremely minute towards the edges of the lobes, that they require the fineſt glaſſes to render them viſible. To theſe ramifications Grew and Malpighi have given the name of *ſeminal root;* becauſe, by means of it, the radicle and plume, before they are expanded, derive their principal nouriſhment.

Plate CCCXCI.

The plume, bud, or germ (fig. 3.), is incloſed in two ſmall correſponding cavities in each lobe. Its colour and conſiſtence is much the ſame with thoſe of the radicle, of which it is only a continuation, but having a quite contrary direction; for the radicle deſcends into the earth, and divides into a great number of ſmaller branches or filaments; but the plume aſcends into the open air, and unfolds itſelf into all the beautiful variety of ſtem, branches, leaves, flowers, fruit, &c. The plume in corn ſhoots from the ſmaller end of the grain, and among maltſters goes by the name of *acroſpire.*

Plate CCCXCIV.

The next thing to be taken notice of is the ſubſtance or parenchymatous part of the lobes. This is not a mere concreted juice, but is curiouſly organized, and conſiſts of a vaſt number of ſmall bladders reſembling thoſe in the pith of trees (fig. 4.)

Beſides the coats, cuticle, and parenchymatous parts, there is a ſubſtance perfectly diſtinct from theſe, diſtributed in different proportions through the radicle, plume, and lobes. This inner ſubſtance appears very plainly in a tranſverſe ſection of the radicle or plume. Towards the extremity of the radicle it is one entire trunk; but higher up it divides into three branches; the middle one runs directly up to the plume, and the other two paſs into the lobes on each ſide, and ſpread out into a great variety of ſmall branches through the whole body of the lobes (fig. 4.) This ſubſtance is very properly termed the *ſeminal root:* for when the ſeed is ſown, the moiſture is firſt abſorbed by the outer coats, which are everywhere furniſhed with ſap and air-veſſels; from theſe it is conveyed to the cuticle; from the cuticle it proceeds to the pulpy part of the lobes; when it has got thus far, it is taken up by the mouths of the ſmall branches of the ſeminal root, and paſſes from one branch into another, till it is all collected into the main trunk, which communicates both with the plume and radicle, the two principle involved organs of the future plant. After this the ſap or vegetable food runs in two oppoſite directions: part of it aſcends into the plume, and promotes the growth and expanſion of that organ; and part of it deſcends into the radicle, for nouriſhing and evolving the root and its various filaments. Thus the plume and radicle continue their progreſs in oppoſite directions till the plant arrives at maturity.

Plate CCCXCI.

Plant.

It is here worth remarking, that every plant is really poffeffed of two roots, both of which are contained in the feed. The plume and radicle, when the feed is firft depofited in the earth, derive their nourifhment from the feminal root; but, afterwards, when the radicle begins to fhoot out its filaments, and to abforb fome moifture, not, however, in a fufficient quantity to fupply the exigencies of the plume, the two lobes, or main body of the feed, rife along with the plume, affume the appearance of two leaves, refembling the lobes of the feed in fize and fhape, but having no refemblance to thofe of the plume, for which reafon they have got the name of *diffimilar leaves*.

Thefe diffimilar leaves defend the young plume from the injuries of the weather, and at the fame time, by abforbing dew, air, &c. affift the tender radicle in nourifhing the plume, with which they have ftill a connection by means of the feminal root above defcribed. But when the radicle or fecond root has defcended deep enough into the earth, and has acquired a fufficient number of filaments or branches for abforbing as much aliment as is proper for the growth of the plume; then the feminal or diffimilar leaves, their utility being entirely fuperfeded, begin to decay and fall off.

Plate CCCXCIV Fig. 1. A, the foramen or hole in the bean through which the radicle fhoots into the foil.

Fig. 2. A tranfverfe fection of the bean; the dots being the branches of the feminal root.

Fig. 3. A, the radicle. B, the plume or bud.

Fig. 4. A, a longitudinal fection of one of the lobes of the bean a little magnified, to fhow the fmall bladders of which the pulpy or parenchymatous part is compofed.

Figs. 5. 6. A, a tranfverfe fection of the radicle. B, a tranfverfe fection of the plume, fhowing the organs or veffels of the feminal root.

Plate CCCXCI. Fig. 4. A view of the feminal root branched out upon the lobes.

Plate CCCXCIV Fig. 7. The appearance of the radicle, plume, and feminal root, when a little further advanced in growth.

Having thus briefly defcribed the feed, and traced its evolution into three principal organic parts, viz. the plume, radicle, and feminal leaves, we fhall next take an anatomical view of the root, trunk, leaves, &c.

2. *Of the root.*] In examining the root of plants, the firft thing that prefents itfelf is the fkin, which is of various colours in different plants. Every root, after it has arrived at a certain age, has a double fkin. The firft is coeval with the other parts, and exifts in the feed: but afterwards there is a ring fent off from the bark, and forms a fecond fkin; *e. g.* in the root of the dandelion, towards the end of May, the original or outer fkin appears fhrivelled, and is eafily feparated from the new one, which is frefher, and adheres more firmly to the bark. Perennial plants are fupplied in this manner with a new fkin every year; the outer one always falls off in the autumn and winter, and a new one is formed from the bark in the fucceeding fpring. The fkin has numerous cells or veffels, and is a continuation of the parenchymatous part of the radicle. However, it does not confift folely of parenchyma; for the microfcope fhows that there are many tubular ligneous veffels interfperfed through it.

When the fkin is removed, the true cortical fubftance or bark appears, which is alfo a continuation of the parenchymatous part of the radicle, but greatly augmented. The bark is of very different fizes. In moft trees it is exceeding thin in proportion to the wood and pith. On the other hand, in carrots, it is almoft one-half of the femidiameter of the root; and, in dandelion, it is nearly twice as thick as the woody part.

The bark is compofed of two fubftances; the parenchyma or pulp, which is the principal part, and a few woody fibres. The parenchyma is exceedingly porous, and has a great refemblance to a fponge; for it fhrivels confiderably when dried, and dilates to its former dimenfions when infufed in water. Thefe pores or veffels are not pervious, fo as to communicate with each other; but confift of diftinct little cells or bladders, fcarcely vifible without the affiftance of the microfcope. In all roots, thefe cells are conftantly filled with a thin watery liquor. They are generally of a fpherical figure; though in fome roots, as the buglofs and dandelion, they are oblong. In many roots, as the horfe-radifh, peony, afparagus, potatoe, &c. the parenchyma is of one uniform ftructure. But in others it is more diverfified, and puts on the fhape of rays, running from the centre towards the circumference of the bark. Thefe rays fometimes run quite through the bark, as in lovage; and fometimes advance towards the middle of it, as in melilot and moft of the leguminous and umbelliferous plants. Thefe rays generally ftand at an equal diftance from each other in the fame plant; but the diftance varies greatly in different plants. Neither are they of equal fizes: in carrot they are exceedingly fmall, and fcarcely difcernible; in melilot and chervil, they are thicker. They are likewife more numerous in fome plants than in others. Sometimes they are of the fame thicknefs from one edge of the bark to the other; and fome grow wider as they approach towards the fkin. The veffels with which thefe rays are amply furnifhed, are fuppofed to be air-veffels, becaufe they are always found to be dry, and not fo tranfparent as the veffels which evidently contain the fap.

In all roots there are ligneous veffels difperfed in different proportions through the parenchyma of the bark. Thefe ligneous veffels run longitudinally through the bark in the form of fmall threads, which are tubular, as is evident from the rifing of the fap in them when a root is cut tranfverfely. Thefe ligneous fap-veffels do not run in direct lines through the bark, but at fmall diftances incline towards one another, in fuch a manner that they appear to the naked eye to be inofculated; but the microfcope difcovers them to be only contiguous, and braced together by the parenchyma. Thefe braces or coarctations are very various both in fize and number in different roots; but in all plants they are moft numerous towards the inner edge of the bark. Neither are thefe veffels fingle tubes; but, like the nerves in animals, are bundles of 20 or 30 fmall contiguous cylindrical tubes, which uniformly run from the extremity of the root, without fending off any branches or fuffering any change in their fize or fhape.

In fome roots, as parfnep, efpecially in the ring next the inner extremity of the bark, thefe veffels contain a kind of lymph, which is fweeter than the fap contained in the bladders of the parenchyma. From this circumftance they have got the name of *lymph-ducts*.

Thefe lymph-ducts fometimes yield a mucilaginous lymph, as in the comphrey; and fometimes a white milky

Plant. milky glutinous lymph, as in the angelica, fonchus, burdock, fcorzonera, dandelion, &c. The lymph-ducts are fuppofed to be the veffels from which the gums and balfams are fecerned. The lymph of fennel, when expofed to the air, turns into a clear tranfparent balfam; and that of the fcorzonera, dandelion, &c. condenfes into a gum.

The fituation of the veffels is various. In fome plants they ftand in a ring or circle at the inner edge of the bark, as in afparagus; in others, they appear in lines or rays, as in borage; in the parfnep, and feveral other plants, they are moft confpicuous towards the outer edge of the bark; and in the dandelion, they are difpofed in the form of concentric circles.

The wood of roots is that part which appears after the bark is taken off, and is firmer and lefs porous than the bark or pith. It confifts of two diftinct fubftances, viz. the pulpy or parenchymatous, and the ligneous. The wood is connected to the bark by large portions of the bark inferted into it. Thefe infertions are moftly in the form of rays, tending to the centre of the pith, which are eafily difcernible by the eye in a tranfverfe fection of moft roots. Thefe infertions, like the bark, confift of many veffels, moftly of a round or oval figure.

The ligneous veffels are generally difpofed in collateral rows running longitudinally through the root. Some of thefe contain air, and others fap. The *air-veffels* are fo called, becaufe they contain no liquor. Thefe air-veffels are diftinguifhed by being whiter than the others.

The pith is the central part of the root. Some roots have no pith, as the ftramonium, nicotiana, &c.; others have little or none at the extremities of the roots, but have a confiderable quantity of it near the top. The pith, like every other part of a plant, is derived from the feed; but in fome it is more immediately derived from the bark: for the infertions of the bark running in betwixt the rays of the wood, meet in the centre, and conftitute the pith. It is owing to this circumftance, that, among roots which have no pith in their lower parts, they are amply provided with it towards the top, as in columbine, lovage, &c.

The bladders of the pith are of very different fizes, and generally of a circular figure. Their pofition is more uniform than in the bark. Their fides are not mere films, but a compofition of fmall fibres or threads; which gives the pith, when viewed with a microfcope, the appearance of a piece of fine gauze or net-work.

We fhall conclude the defcription of roots with obferving, that their whole fubftance is nothing but a congeries of tubes and fibres, adapted by nature for the abforption of nourifhment, and of courfe the extenfion and augmentation of their parts.

Plate CCCXCIV

Fig. 8. A tranfverfe fection of the root of wormwood as it appears to the naked eye.

Fig. 9. A fection of fig. 8. magnified. AA, the fkin, with its veffels. BBBB, the bark. The round holes CCC, &c. are the lymph-ducts of the bark: All the other holes are little cells and fap-veffels. DDD, parenchymatous infertions from the bark, with the cells, &c. EEEE, the rays of the wood, in which the holes are the air-veffels. *N. B.* This root has no pith.

3. *Of the Trunk, Stalk, or Stem.*] In defcribing the trunks of plants, it is neceffary to premife, that whatever is faid with regard to them applies equally to the branches.

The trunk, like the root, confifts of three parts, viz. the bark, wood, and pith. Thefe parts, though fubftantially the fame in the trunk as in the root, are in many cafes very different in their texture and appearance.

The fkin of the bark is compofed of very minute bladders, interfperfed with longitudinal woody fibres, as in the nettle, thiftle, and moft herbs. The outfide of the fkin is vifibly porous in fome plants, particularly the cane.

The principal body of the bark is compofed of pulp or parenchyma, and innumerable veffels much larger than thofe of the fkin. The texture of the pulpy part, though the fame fubftance with the parenchyma in roots, yet feldom appears in the form of rays running towards the pith; and when thefe rays do appear, they do not extend above half way to the circumference. The veffels of the bark are very differently fituated, and deftined for various purpofes in different plants. For example, in the bark of the pine, the inmoft are lymph ducts, and exceedingly fmall; the outmoft are gum or refiniferous veffels, deftined for the fecretion of turpentine; and are fo large as to be diftinctly vifible to the naked eye.

The wood lies between the bark and pith, and confifts of two parts, viz. a parenchymatous and ligneous. In all trees, the parenchymatous part of the wood, though much diverfified as to fize and confiftence, is uniformly difpofed in diametrical rays, or infertions running betwixt fimilar rays of the ligneous part.

The true wood is nothing but a congeries of old dried lymph-ducts. Between the bark and the wood a new ring of thefe ducts is formed every year, which gradually lofes its foftnefs as the cold feafon approaches, and towards the middle of winter is condenfed into a folid ring of wood. Thefe annual rings, which are diftinctly vifible in moft trees when cut through, ferve as natural marks to diftinguifh their age (fig. 10. 11.) The rings of one year are fometimes larger, fometimes lefs, than thofe of another, probably owing to the favourablenefs or unfavourablenefs of the feafon. Plate CCCXCIV

The pith, though of a different texture, is exactly of the fame fubftance with the parenchyma of the bark, and the infertions of the wood. The quantity of pith is various in different plants. Inftead of being increafed every year like the wood, it is annually diminifhed, its veffels drying up, and affuming the appearance and ftructure of wood; infomuch that in old trees there is fcarce fuch a thing as pith to be difcerned.

A ring of fap-veffels are ufually placed at the outer edge of the pith, next the wood. In the pine, fig, and walnut, they are very large. The parenchyma of the pith is compofed of fmall cells or bladders, of the fame kind with thofe of the bark, only of a larger fize. The general figure of thefe bladders is circular; though in fome plants, as the thiftle and borage, they are angular. Though the pith is originally one connected chain of bladders, yet as the plant grows old they fhrivel, and open in different directions. In the walnut, after a certain age, it appears in the form of a regular tranfverfe hollow divifion. In fome plants it is altogether wanting; in others, as the fonchus, nettle, &c. there is only a tranfverfe partition of it at every joint. Many other varieties might be mentioned; but thefe muft be left to the obfervation of the reader.

Plant.

Plate CCCXCIV

Fig. 10. A tranſverſe ſection of a branch of aſh, as it appears to the eye.

Fig. 11. The ſame ſection magnified. AA, the bark. BBB, an arched ring of ſap-veſſels next the ſkin. CCC, the parenchyma of the bark with its cells, and another arched ring of ſap-veſſels. DD, a circular line of lymph-ducts immediately below the above arched ring. EE, the wood. F, the firſt year's growth. G, the ſecond. H, the third year's growth. III, the true wood. KK, the great air-veſſels. LL, the leſſer ones. MMM, the parenchymatous inſertions of the bark repreſented by the white rays. NO, the pith, with its bladders or cells.

4. *Of the Leaves.*] The leaves of plants conſiſt of the ſame ſubſtance with that of the trunk. They are full of nerves or woody portions, running in all directions, and branching out into innumerable ſmall threads, interwoven with the parenchyma like fine lace or gauze.

The ſkin of the leaf, like that of an animal, is full of pores, which both ſerve for perſpiration and for the abſorption of dews, air, &c. Theſe pores or orifices differ both in ſhape and magnitude in different plants, which is the cauſe of that variety of texture or grain peculiar to every plant.

The pulpy or parenchymatous part conſiſts of very minute fibres, wound up into ſmall cells or bladders. Theſe cells are of various ſizes in the ſame leaf.

All leaves, of whatever figure, have a marginal fibre, by which all the reſt are bounded. The particular ſhape of this fibre determines the figure of the leaf.

The veſſels of leaves have the appearance of inoſculating; but, when examined by the microſcrope, they are found only to be interwoven or laid along each other.

What are called *air-veſſels*, or thoſe which carry no ſap, are viſible even to the naked eye in ſome leaves. When a leaf is ſlowly broke, they appear like ſmall woolly fibres, connected to both ends of the broken piece.

Plate CCCXCV

Fig. 14. The appearance of the air-veſſels to the eye, in a vine-leaf drawn gently aſunder.

Fig. 15. A ſmall piece cut off that leaf.

Fig. 16. The ſame piece magnified, in which the veſſels have the appearance of a ſcrew.

Fig. 17. The appearance of theſe veſſels as they exiſt in the leaf before they are ſtretched out.

5. *Of the Flower.*] It is needleſs here to mention any thing of the texture, or of the veſſels, &c. of flowers, as they are pretty ſimilar to thoſe of the leaf. It would be foreign to our preſent purpoſe to take any notice of the characters and diſtinctions of flowers. Theſe belong to the ſcience of BOTANY, to which the reader is referred.

There is one curious fact, however, which muſt not be omitted, viz. That every flower is perfectly formed in its parts many months before it appears outwardly; that is, the flowers which appear this year are not properly ſpeaking the flowers of this year, but of the laſt. For example, mezereon generally flowers in January; but theſe flowers were completely formed in the month of Auguſt preceding. Of this fact any one may ſatiſfy himſelf by ſeparating the coats of a tulip-root about the beginning of September; and he will find that the two innermoſt form a kind of cell, in the centre of which ſtands the young flower, which is not to make its appearance till the following April or May. Fig. 18. exhibits a view of the tulip-root when diſſected in September, with the young flower towards the bottom.

6. *Of the Fruit.*] In deſcribing the ſtructure of fruits, a few examples ſhall be taken from ſuch as are moſt generally known.

A *pear*, beſides the ſkin, which is a production of the ſkin of the bark, conſiſts of a double parenchyma or pulp, ſap, and air-veſſels, calculary and acetary.

The outer parenchyma is the ſame ſubſtance continued from the bark, only its bladders are larger and more ſucculent.

It is everywhere interſperſed with ſmall globules or grains, and the bladders reſpect theſe grains as a kind of centres, every grain being the centre of a number of bladders. The ſap and air-veſſels in this pulp are extremely ſmall.

Next the core is the inner pulp or parenchyma, which conſiſts of bladders of the ſame kind with the outer, only larger and more oblong, correſponding to thoſe of the pulp, from which it ſeems to be derived. This inner pulp is much ſourer than the other, and has none of the ſmall grains interſperſed through it; and hence it has got the name of *acetary*.

Between the acetary and outer pulp, the globules or grains begin to grow larger, and gradually unite into a hard ſtony body, eſpecially towards the corculum or ſtool of the fruit; and from this circumſtance it has been called the *calculary*.

Theſe grains are not derived from any of the organical parts of the tree; but ſeem rather to be a kind of concretions precipitated from the ſap, ſimilar to the precipitation from wine, urine, and other liquors.

The core is a roundiſh cavity in the centre of the pear, lined with a hard woody membrane, in which the ſeed is incloſed. At the bottom of the core there is a ſmall duct or canal, which runs up to the top of the pear; this canal allows the air to get into the core, for the purpoſe of drying and ripening the ſeeds.

Fig. 19. a tranſverſe ſection of a pear, as it appears to the naked eye. A, the ſkin, and a ring of ſap-veſſels. B, the outer parenchyma, or pulp, with its veſſels, and ligneous fibres interſperſed. C, the inner parenchyma, or acetary, with its veſſels, which are larger than the outer one. D, the core and ſeeds. Plate CCCXCVI

Fig. 20. a piece cut off fig. 19.

Fig. 21. is fig. 20. magnified. A A A, the ſmall grains or globules, with the veſſels radiated from them.

Fig. 22. a longitudinal ſection of the pear, ſhowing a different view of the ſame parts with thoſe of fig. 19. A the channel, or duct, which runs from the top of the pear to the bottom of the core.

In a *lemon*, the parenchyma appears in three different forms. The parenchyma of the rind is of a coarſe texture, being compoſed of thick fibres, woven into large bladders. Thoſe neareſt the ſurface contain the eſſential oil of the fruit, which burſts into a flame when the ſkin is ſqueezed over a candle. From this outmoſt parenchyma nine or ten inſertions or lamellæ are produced, which run between as many portions of the pulp, and unite into one body in the centre of the fruit, which correſponds to the pith in trunks or roots. At the bottom and top of the lemon, this pith evidently joins with the rind, without the intervention of any lamellæ. This

 circumſtance ſhows, that the pith and bark are actually connected in the trunk and roots of plants, though it is difficult to demonſtrate the connection, on account of the cloſeneſs of their texture, and the minuteneſs of their fibres. Many veſſels are diſperſed through the whole of this parenchyma; but the largeſt ones ſtand on the inner edge of the rind, and the outer edge of the pith, juſt at the two extremities of each lamella.

The ſecond kind of parenchyma is placed between the rind and the pith; is divided into diſtinct bodies by the lamellæ; and each of theſe bodies forms a large bag.

Theſe bags contain a third parenchyma, which is a cluſter of ſmaller bags, diſtinct and unconnected with each other, having a ſmall ſtalk by which they are fixed to the large bag. Within each of theſe ſmall bags are many hundreds of bladders, compoſed of extremely minute fibres. Theſe bladders contain the acid juice of the lemon.

Plate CCCXCV. Fig. 12. a longitudinal ſection of a lemon. A A A, the rind with the veſſels which contain the eſſential oil. B B, the ſubſtance correſponding to the pith, formed by the union of the lamellæ or inſertions. C C, its continuation and connection with the rind, independent of the inſertions.

Fig. 13. a tranverſe ſection of the lemon. B B B, &c. the nine pulpy bags, or ſecond parenchyma, placed between the rind and the pith; and the cluſter of ſmall bags, which contain the acid juice, incloſed in the large ones. C C, the large veſſels that ſurround the pith. D D, two of the large bags laid open, ſhowing the ſeeds, and their connection with the lamellæ or membranes which form the large bags.

Of the Perſpiration of PLANTS, *and the quantity of moiſture daily imbibed by them.*—Theſe curious particulars have been determined with great accuracy by Dr Hales. The method he took to accompliſh his purpoſe was as follows.—In the month of July, commonly the warmeſt ſeaſon of the year, he took a large ſun-flower three feet and an half high, which had been purpoſely planted in a flower-pot when young. He covered the pot with thin milled lead, leaving only a ſmall hole to preſerve a communication with the external air, and another by which he might occaſionally ſupply the plant with water. Into the former he inſerted a glaſs tube nine inches long, and another ſhorter tube into the hole by which he poured in the water; and the latter was kept cloſe ſtopped with a cork, except when there was occaſion to uſe it. The holes in the bottom of the pot were alſo ſtopped up with corks, and all the crevices ſhut with cement.—Things being thus prepared, the pot and plant were weighed for 15 ſeveral days; after which the plant was cut off cloſe to the leaden plate, and the ſtump well covered with cement. By weighing, he found that there perſpired through the unglazed porous pot two ounces every 12 hours; which being allowed for in the daily weighing of the plant and pot, the greateſt perſpiration, in a warm day, was found to be one pound 14 ounces; the middle rate of perſpiration, one pound four ounces; the perſpiration of a dry warm night, without any ſenſible dew, was about three ounces; but when there was any ſenſible though ſmall dew, the perſpiration was nothing; and when there was a large dew, or ſome little rain in the night, the plant and pot was increaſed in weight two or three ounces.

In order to know what quantity was perſpired from a ſquare inch of ſurface, our author cut off all the leaves of the plant, and laid them in five ſeveral parcels, according to their ſeveral ſizes; and then meaſured the ſurface of a leaf of each parcel, by laying over it a large lattice made with threads, in which each of the little ſquares were $\frac{1}{4}$ of an inch; by numbering of which, he had the ſurface of the leaves in ſquare inches; which, multiplied by the number of leaves in the correſponding parcels, gave the area of all the leaves. By this method he found the ſurface of the whole plant above ground to be 5616 ſquare inches, or 39 ſquare feet. He dug up another ſun-flower of nearly the ſame ſize, which had eight main roots, reaching 15 inches deep and ſidewiſe, from the ſtem. It had beſides a very thick buſh of lateral roots from the eight main roots, extending every way in a hemiſphere about nine inches from the ſtem and main roots. In order to eſtimate the length of all the roots, he took one of the main roots with its laterals, and meaſured and weighed them; and then weighed the other ſeven with their laterals; by which means he found the ſum of all their lengths to be 1448 feet. Suppoſing then the periphery of theſe roots at a medium to be 0.131 of an inch, then their ſurface will be 2276 ſquare inches, or 15.8 ſquare feet; that is, equal to 0.4 of the ſurface of the plant above ground. From calculations drawn from theſe obſervations, it appears, that a ſquare inch of the upper ſurface of this plant perſpires $\frac{1}{165}$ part of an inch in a day and a night; and that a ſquare inch of the ſurface underground imbibed $\frac{1}{67}$ of an inch in the ſame time.

The quantity perſpired by different plants, however, is by no means equal. A vine-leaf perſpires only $\frac{1}{191}$ of an inch in 12 hours; a cabbage perſpires $\frac{1}{80}$ of an inch in the ſame time; an apple-tree $\frac{1}{102}$ in 12 hours; and a lemon $\frac{1}{248}$ in 12 hours.

Of the circulation of the Sap in PLANTS.—Concerning this there have been great diſputes; ſome maintaining, that the vegetable ſap has a circulation analogous to the blood of animals; while others affirm, that it only aſcends in the day-time, and deſcends again in the night. In favour of the doctrine of circulation it has been urged, that upon making a tranſverſe inciſion into the trunk of a tree, the juice which runs out proceeds in greater quantity from the upper than the lower part; and the ſwelling in the upper lip is alſo much greater than in the lower. It appears, however, that when two ſimilar inciſions are made, one near the top and the other near the root, the latter expends much more ſap than the former. Hence it is concluded, that the juice aſcends by one ſet of veſſels and deſcends by another. But, in order to ſhow this clearly, it would be neceſſary firſt to prove that there is in plants, as in animals, ſome kind of centre from which the circulation begins, and to which it returns; but no ſuch centre has been diſcovered by any naturaliſt; neither is there the leaſt proviſion apparently made by nature whereby the ſap might be prevented from deſcending in the very ſame veſſels through which it aſcends. In the lacteal veſſels of animals, which we may ſuppoſe to be analogous to the roots of vegetables, there are valves which effectually

Plant.

ly prevent the chyle when once abſorbed from returning into the inteſtines; but no ſuch thing is obſerved in the veſſels of vegetables: whence it muſt be very probable, that when the propelling force ceaſes, the juice deſcends by the very ſame veſſels through which it aſcended.—This matter, however, has been cleared up almoſt as well as the nature of the ſubject will admit of by the experiments of Dr Hales ‡. Theſe experiments are ſo numerous, that for a particular account of them we muſt refer to the work itſelf; however, his reaſoning againſt the circulation of the ſap will be ſufficiently intelligible without them. "We ſee (ſays he), in many of the foregoing experiments, what quantities of moiſture trees daily imbibe and perſpire: now the celerity of the ſap muſt be very great, if that quantity of moiſture muſt, moſt of it, aſcend to the top of the tree, then deſcend, and aſcend again, before it is carried off by perſpiration.

‡ *Vegetable Statics*, vol. i. p. 142.

"The defect of a circulation in vegetables ſeems in ſome meaſure to be ſupplied by the much greater quantity of liquor, which the vegetable takes in, than the animal, whereby its motion is accelerated; for we find the ſun-flower, bulk for bulk, imbibes and perſpires 17 times more freſh liquor than a man, every 24 hours.

"Beſides, Nature's great aim in vegetables being only that the vegetable life be carried on and maintained, there was no occaſion to give its ſap the rapid motion which was neceſſary for the blood of animals.

"In animals, it is the heart which ſets the blood in motion, and makes it continually circulate; but in vegetables we can diſcover no other cauſe of the ſap's motion but the ſtrong attraction of the capillary ſap-veſſels, aſſiſted by the briſk undulations and vibrations cauſed by the ſun's warmth, whereby the ſap is carried up to the top of the talleſt trees, and is there perſpired off through the leaves: but when the ſurface of the tree is greatly diminiſhed by the loſs of its leaves, then alſo the perſpiration and motion of the ſap is proportionably diminiſhed, as is plain from many of the foregoing experiments: ſo that the aſcending velocity of the ſap is principally accelerated by the plentiful perſpiration of the leaves, thereby making room for the fine capillary veſſels to exert their vaſtly attracting power, which perſpiration is effected by the briſk rarefying vibrations of warmth; a power that does not ſeem to be any ways well adapted to make the ſap deſcend from the tops of vegetables by different veſſels to the root.

"If the ſap circulated, it muſt needs have been ſeen deſcending from the upper part of large gaſhes cut in branches ſet in water, and with columns of water preſſing on their bottoms in long glaſs tubes. In both which caſes, it is certain that great quantities of water paſſed through the ſtem, ſo that it muſt needs have been ſeen deſcending, if the return of the ſap downwards were by truſion or pulſion, whereby the blood in animals is returned through the veins to the heart; and that pulſion, if there were any, muſt neceſſarily be exerted with prodigious force, to be able to drive the ſap through the finer capillaries. So that, if there be a return of the ſap downwards, it muſt be by attraction, and that a very powerful one, as we may ſee by many of theſe experiments. But it is hard to conceive what and where that power is which can be equivalent to that proviſion nature has made for the aſcent of the ſap in conſequence of the great perſpiration of the leaves.

Plant.

"The inſtances of the jeſſamine-tree, and of the paſſion-tree, have been looked upon as ſtrong proofs of the circulation of the ſap, becauſe their branches, which were far below the inoculated bud, were gilded: but we have many viſible proofs in the vine, and other bleeding trees, of the ſap's receding back, and puſhing forwards alternately, at different times of the day and night. And there is great reaſon to think that the ſap of all other trees has ſuch an alternate, receding, and progreſſive motion, occaſioned by the alternacies of day and night, warm and cool, moiſt and dry.

"For the ſap in all vegetables does probably recede in ſome meaſure from the tops of the branches, as the ſun leaves them; becauſe its rarefying power then ceaſing, the greatly rarefied ſap, and air mixed with it, will condenſe, and take up leſs room than they did, and the dew and rain will then be ſtrongly imbibed by the leaves; whereby the body and branches of the vegetable which have been much exhauſted by the great evaporation of the day, may at night imbibe ſap and dew from the leaves; for by ſeveral experiments, plants were found to increaſe conſiderably in weight, in dewy and moiſt nights. And by other experiments on the vine, it was found that the trunk and branches of vines were always in an imbibing ſtate, cauſed by the great perſpiration of the leaves, except in the bleeding ſeaſon; but when at night that perſpiring power ceaſes, then the contrary imbibing power will prevail, and draw the ſap and dew from the leaves, as well as moiſture from the roots.

"And we have a farther proof of this by fixing mercurial gages to the ſtems of ſeveral trees which do not bleed, whereby it is found that they are always in a ſtrongly imbibing ſtate, by drawing up the mercury ſeveral inches: whence it is eaſy to conceive, how ſome of the particles of the gilded bud in the inoculated jeſſamine may be abſorbed by it, and thereby communicate their gilding miaſma to the ſap of other branches; eſpecially when, ſome months after the inoculation, the ſtock of the inoculated jeſſamine is cut off a little above the bud; whereby the ſtock, which was the counteracting part to the ſtem, being taken away, the ſtem attracts more vigorouſly from the bud.

"Another argument for the circulation of the ſap is, that ſome ſorts of the graffs will infect and canker the ſtocks they are grafted on: but by mercurial gages fixed to freſh-cut ſtems of trees, it is evident that thoſe ſtems were in a ſtrongly imbibing ſtate; and conſequently the cankered ſtocks might very likely draw ſap from the graff, as well as the graff alternately from the ſtock; juſt in the ſame manner as leaves and branches do from each other, in the viciſſitudes of day and night. And this imbibing power of the ſtock is ſo great, where only ſome of the branches of a tree are grafted, that the remaining branches of the ſtock will, by their ſtrong attraction, ſtarve thoſe graffs; for which reaſon it is uſual to cut off the greateſt part of the branches of the ſtock, leaving only a few ſmall ones to draw up the ſap.

"The inſtance of the ilex grafted upon the Engliſh oak, ſeems to afford a very conſiderable argument againſt a circulation. For, if there were a free uniform

form circulation of the ſap through the oak and ilex, why ſhould the leaves of the oak fall in winter, and not thoſe of the ilex?

"Another argument againſt an uniform circulation of the ſap in trees, as in animals, may be drawn from an experiment, where it was found by the three mercurial gages fixed to the ſame vine, that while ſome of its branches changed their ſtate of protruding ſap into a ſtate of imbibing, others continued protruding ſap; one nine, and the other thirteen days longer."

To this reaſoning of Dr Hales we ſhall ſubjoin an experiment made by Mr Muſtel of the Academy of Sciences at Rouen, which ſeems deciſive againſt the doctrine of circulation. His account of it is as follows.—"On the 12th of January I placed ſeveral ſhrubs in pots againſt the windows of my hot-houſe, ſome within the houſe and others without it. Through holes made for this purpoſe in the panes of glaſs, I paſſed a branch of each of the ſhrubs, ſo that thoſe on the inſide had a branch without, and thoſe on the outſide one within; after this, I took care that the holes ſhould be exactly cloſed and luted. This inverſe experiment, I thought, if followed cloſely, could not fail affording ſufficient points of compariſon, to trace out the differences, by the obſervation of the effects.

"The 20th of January, a week after this diſpoſition, all the branches that were in the hot-houſe began to diſcloſe their buds. In the beginning of February there appeared leaves; and towards the end of it, ſhoots of a conſiderable length, which preſented the young flowers. A dwarf apple-tree, and ſeveral roſe-trees, being ſubmitted to the ſame experiment, ſhowed the ſame appearance then as they commonly put on in May; in ſhort, all the branches which were within the hot-houſe, and conſequently kept in the warm air, were green at the end of February, and had their ſhoots in great forwardneſs. Very different were thoſe parts of the ſame tree which were without and expoſed to the cold. None of theſe gave the leaſt ſign of vegetation; and the froſt, which was intenſe at that time, broke a roſe-pot placed on the outſide, and killed ſome of the branches of that very tree which, on the inſide, was every day putting forth more and more ſhoots, leaves, and buds, ſo that it was in full vegetation on one ſide, whilſt frozen on the other.

"The continuance of the froſt occaſioned no change in any of the internal branches. They all continued in a very briſk and verdant ſtate, as if they did not belong to the tree which, on the outſide, appeared in the ſtate of the greateſt ſuffering. On the 15th of March, notwithſtanding the ſeverity of the ſeaſon, all was in full bloom. The apple-tree had its root, its ſtem, and part of its branches, in the hot-houſe. Theſe branches were covered with leaves and flowers; but the branches of the ſame tree, which were carried on the outſide, and expoſed to the cold air, did not in the leaſt partake of the activity of the reſt, but were abſolutely in the ſame ſtate which all trees are in during winter. A roſe-tree, in the ſame poſition, ſhowed long ſhoots with leaves and buds; it had even ſhot a vigorous branch upon its ſtalk; whilſt a branch which paſſed through to the outſide had not begun to produce any thing, but was in the ſame ſtate with other roſe-trees left in the ground. This branch is four lines in diameter, and 18 inches high.

"The roſe-tree on the outſide was in the ſame ſtate; but one of its branches drawn through to the inſide of the hot-houſe was covered with leaves and roſe-buds. It was not without aſtoniſhment that I ſaw this branch ſhoot as briſkly as the roſe-tree which was in the hot-houſe, whoſe roots and ſtalk, expoſed as they were to the warm air, ought, it ſhould ſeem, to have made it get forwarder than a branch belonging to a tree, whoſe roots, trunk, and all its other branches, were at the very time froſt-nipped. Notwithſtanding this, the branch did not ſeem affected by the ſtate of its trunk; but the action of the heat upon it produced the ſame effect as if the whole tree had been in the hot-houſe."

Of the Perpendicularity of PLANTS.—This is a curious phenomenon in natural hiſtory, which was firſt obſerved by M. Dodart, and publiſhed in an eſſay on the affectation of perpendicularity obſerved in the ſtems or ſtalks of all plants, in the roots of many, and even in their branches, as much as poſſible. Though almoſt all plants riſe a little crooked, yet the ſtems ſhoot up perpendicularly, and the roots ſink down perpendicularly: even thoſe, which by the declivity of the ſoil come out inclined, or thoſe which are diverted out of the perpendicular by any violent means, again redreſs and ſtraighten themſelves and recover their perpendicularity, by making a ſecond and contrary bend or elbow without rectifying the firſt. We commonly look upon this affectation without any ſurpriſe; but the naturaliſt who knows what a plant is, and how it is formed, finds it a ſubject of aſtoniſhment.

Memoires de l'Acad. Royal des Sciences, an. 1708.

Each ſeed we know contains in it a little plant, already formed, and needing nothing but to be unfolded; the little plant has its root; and the pulp, which is uſually ſeparated into two lobes, is the foundation of the firſt food it draws by its root when it begins to germinate. If a ſeed in the earth therefore be diſpoſed ſo as that the root of the little plant be turned downwards, and the ſtem upwards, and even perpendiculary upwards, it is eaſy to conceive that the little plant coming to unfold itſelf, its ſtalk and root need only follow the direction they have to grow perpendicularly. But we know that the ſeeds of plants, whether ſown of themſelves or by man, fall in the ground at random; and among the great variety of ſituations with regard to the ſtalk of their plant, the perpendicular one upwards is but one. In all the reſt, therefore, it is neceſſary that the ſtalk rectify itſelf, ſo as to get out of the ground: but what force effects this change, which is unqueſtionably a violent action? Does the ſtalk find a leſs load of earth above it, and therefore go naturally that way where it finds the leaſt obſtacle? Were this ſo, the little root, when it happens to be uppermoſt, muſt alſo follow that direction, and mount up.

To account for two ſuch different actions, M. Dodart ſuppoſes that the fibres of the ſtalks are of ſuch a nature as to be contracted and ſhortened by the heat of the ſun, and lengthened out by the moiſture of the earth; and, on the contrary, that the fibres of the roots are contracted by the moiſture of the earth, and lengthened by the heat of the ſun. When the plantule therefore is inverted, and the root at the top, the fibres which compoſe one of the branches of the root are not alike expoſed to the moiſture of the earth, the lower part being more expoſed than the upper. The lower muſt of courſe contract the moſt; and this contraction is again promoted by the lengthening of the upper, where-

on the fun acts with the greateft force. This branch of the root muft therefore recoil towards the earth, and, infinuating through the pores thereof, muft get underneath the bulb, &c. By inverting this reafoning we difcover how the ftalk comes to get uppermoft.

We fuppofe then that the earth attracts the root to itfelf, and that the fun contributes to its defcent; and, on the other hand, that the fun attracts the ftem, and the earth contributes to fend it towards the fame. With refpect to the ftraightening of the ftalks in the open air, our author imagines that it arifes from the impreffion of external caufes, particularly the fun and rain. For the upper part of a ftalk that is bent is more expofed to the rain, dew, and even the fun, &c. than the under; and thefe caufes, in a certain ftructure of the fibres, both equally tend to ftraighten the part moft expofed by the fhortening they fucceffively occafion in it; for moifture fhortens by fwelling and heat by diffipating. What that ftructure is which gives the fibres fuch different qualities, or whereon it depends, is a myftery as yet beyond our depth.

M. de la Hire accounts for the perpendicularity of the ftems or ftalks of plants in this manner: he fuppofes that the root of plants draws a coarfer and heavier juice, and the ftem and branches a finer and more volatile one. Moft naturalifts indeed conceive the root to be the ftomach of the plant, where the juices of the earth are fubtilized fo as to become able to rife through the ftem to the extremity of the branches. This difference of juices fuppofes larger pores in the roots than the ftalk, &c. and, in a word, a different contexture. This difference muft be found even in the little invifible plant inclofed in the feed: in it, therefore, we may conceive a point of feparation; fuch as, that all on one fide, for example the root, fhall be unfolded by the groffer juices, and all on the other fide by the more fubtile ones. Suppofe the plantule, when its parts begin to unfold, to be entirely inverted, the root at the top, and the ftalk below; the juices entering the root will be coarfeft, and when they have opened and enlarged the pores fo as to admit juices of a determinate weight, thofe juices preffing the root more and more will drive it downwards; and this will increafe as the root is more extended or enlarged: for the point of feparation being conceived as the fixed point of a lever, they will act by the longer arm. The volatile juices at the fame time having penetrated the ftalk, will give it a direction from below upwards; and, by reafon of the lever, will give it more and more every day. The little plant is thus turned on its fixed point of feparation till it become perfectly erect.

When the plant is thus erected, the ftalk fhould ftill rife perpendicularly, in order to give it the more firm biding, and enable it to withftand the effort of wind and weather. M. Parent thus accounts for this effect: If the nutritious juice which arrived at the extremity of a rifing ftalk evaporate, the weight of the air which encompaffes it on all fides will make it afcend vertically: but if, inftead of evaporating, it congeal, and remain fixed to that extremity whence it was ready to go off, the weight of the air will give it the fame direction; fo that the ftalk will have acquired a fmall new part vertically laid over it, juft as the flame in a candle held in any way obliquely to the horizon ftill continues vertical by the preffure of the atmofphere. The new drops of juice that fucceed will follow the fame direction; and as all together form the ftalk, that muft of courfe be vertical, unlefs fome particular circumftance intervene.

The branches, which are at firft fuppofed to proceed laterally out of the ftalk in the firft embryo of the plant, though they fhould even come out in an horizontal direction, muft alfo raife themfelves upwards by the conftant direction of the nutritious juice, which at firft fcarce meets any refiftance in a tender fupple branch; and afterwards, even though the branch grow more firm, it will act with the more advantage; fince the branch, being become longer, furnifhes it with a longer arm or lever. The flender action of even a little drop becomes very confiderable by its continuity, and by the affiftance of fuch circumftances. Hence may we account for that regular fituation and direction of the branches, fince they all make nearly the fame conftant angle of 45° with the ftem, and with one another.

M. Aftruc accounts for the perpendicularity of the ftems, and their redreffing themfelves, thus: 1. He thinks the nutritious juice arifes from the circumference of the plant, and terminates in the pith: And, 2. That fluids, contained in tubes either parallel or oblique to the horizon, gravitate on the lower part of the tubes, and not at all on the upper. Hence it follows, that, in a plant placed either obliquely or parallel to the horizon, the nutritious juice will act more on the lower part of the canals than on the upper; and by this means they will infinuate more into the canals communicating therewith, and be collected more copioufly therein: thus the parts on the lower fide will receive more accretion and be more nourifhed than thofe on the upper, the extremity of the plant will therefore be obliged to bend upwards.

This principle brings the feed into its due fituation at firft. In a bean planted upfide down, the plume and radicle may be feen with the naked eye fhooting at firft directly for about an inch; after which they begin to bend, the one downward, and the other upward. The fame is the cafe in a heap of barley to be made into malt, or in a quantity of acorns laid to fprout in a moift place, &c. Each grain of barley and each acorn has a different fituation; and yet every fprout tends directly upward, and every root downward, and the curvity or bend they make is greater or lefs as their fituation approaches more or lefs to the direction wherein no curvature at all would be neceffary. But two fuch oppofite motions cannot poffibly arife without fuppofing fome difference between the two parts: the only one we know of is, that the plume is fed by a juice imported to it by tubes parallel to its fides, whereas the radical imbibes its nourifhment at every pore in its furface. When the plume therefore is either parallel or inclined to the horizon, the nutritious juice, feeding the lower parts more than the upper, will determine its extremes to turn upward, for the reafons before given. On the contrary, when the radicle is in the like fituation, the nutritious juice penetrating through the upper part more copioufly than through the under, there will be a greater accretion of the former than of the latter; and the radicle will therefore be bent downwards, and this mutual curvity of the plume and radicle muft continue till fuch time as their fides are nourifhed alike, which cannot be till they are perpendicular.

Of the Food of Plants.—This hath been fo fully difcuffed

Plants. discussed under the article Agriculture †, that little remains to be said upon the subject in this place. The method of making dephlogisticated or vital air *de novo*, is now so much improved, that numberless experiments may be made with it both on animals and vegetables. It appears, indeed, that these two parts of the creation are a kind of counterbalance to one another; and the noxious parts or excrements of the one prove salutary food to the other. Thus, from the animal body continually pass off certain effluvia, which vitiate or *phlogisticate* the air. Nothing can be more prejudicial to animal life than an accumulation of these effluvia: on the other hand, nothing is more favourable to vegetables than those excrementitious effluvia of animals; and accordingly they greedily absorb them from the earth, or from the air. With respect to the excrementitious parts of living vegetables, the case is reversed. The purest air is the common effluvium which passes off from vegetables; and this, however favourable to animal life, is by no means so to vegetable; whence we have an additional proof of the doctrine concerning the food of plants delivered under the article Agriculture.

† Part i. sect. I.

With regard to the effects of other kinds of air on vegetation, a difference of some consequence took place between Dr Priestley and Dr Percival. The former, in the first volume of his Experiments and Observations on Air, had asserted that fixed air is fatal to vegetable as well as to animal life. This opinion, however, was opposed by Dr Percival, and the contrary one adopted by Dr Hunter of York in the Georgical Essays, vol. v. The experiments related by these two gentlemen would indeed have been decisive, had they been made with sufficient accuracy. That this was the case, however, Dr Priestley denies; and in the 3d volume of his Treatise on Air has fully detected the mistakes in Dr Percival's Experiments; which proceeded in fact from his having used, not fixed air, but common air mixed with a small quantity of fixed air. His experiments, when repeated with the purest fixed air, and in the most careful manner, were always attended with the same effect, namely, the killing of the plant.

It had also been asserted by Drs Percival and Hunter, that water impregnated with fixed air was more favourable to vegetation than simple water. This opinion was likewise examined by Dr Priestley; however, his experiments were indecisive; but seem rather unfavourable to the use of fixed air than otherwise.

Another very remarkable fact with regard to the food of plants has been discovered by Dr Priestley; namely, that some of them, such as the willow, comfrey, and duck-weed, are nourished by inflammable air. The first, he says, flourishes in this species of air so remarkably, that, "it may be said to feed upon it with great avidity. This process terminates in the change of what remains of the inflammable air into phlogisticated air, and sometimes into a species of air as good as common air, or even better; so that it must be the *inflammable principle* in the air that the plant takes, converting it, no doubt, into its proper nourishment."

Priestley on Air, vol. v. p. 2,

What the followers of Stahl call phlogisticated air and inflammable air, are so closely allied to each other, that it is no wonder they should serve promiscuously for the food of plants. The reason why both are not agreeable to all kinds of plants, most probably is the different quantity of phlogistic matter contained in them, and the different action of the latent fire they contain: for all plants do not require an equal quantity of nourishment; and such as require but little, will be destroyed by having too much. The action of heat also is essentially necessary to vegetation; and it is probable that very much of this principle is absorbed from the air by vegetables. But if the air by which plants are partly nourished contains too much of that principle, it is very probable that they may be destroyed from this cause as well as the other; and thus inflammable air, which contains a vast quantity of that active principle, may destroy such plants as grow in a dry soil, though it preserves those which grow in a wet one. See Vegetation.

Dissemination of Plants.—So great are the prolific powers of the vegetable kingdom, that a single plant almost of any kind, if left to itself, would, in a short time, over-run the whole word. Indeed, supposing the plant to have been only a single annual, with two seeds, it would, in 20 years, produce more than a million of its own species; what numbers then must have been produced by a plant whose seeds are so numerous as many of those with which we are acquainted? See *Natural History*, sect. iii. p. 654, &c. In that part of our work we have given particular examples of the very prolific nature of plants, which we need not repeat here; and we have made some observations on the means by which they are carried to distant places. This is a very curious matter of fact, and as such we shall now give a fuller account of it.

If nature had appointed no means for the scattering of these numerous seeds, but allowed them to fall down in the place where they grew, the young vegetables must of necessity have choaked one another as they grew up, and not a single plant could have arrived at perfection. But so many ways are there appointed for the dissemination of plants, that we see they not only do not hinder each others growth, but a single plant will in a short time spread through different countries. The most evident means for this purpose are,

1. The force of the air.—That the efficacy of this may be the greater, nature has raised the seeds of vegetables upon stalks, so that the wind has thus an opportunity of acting upon them with the greater advantage. The seed-capsules also open at the apex, lest the ripe seeds should drop out without being widely dispersed by the wind. Others are furnished with wings, and a pappous down, by which, after they come to maturity, they are carried up into the air, and have been known to fly the distance of 50 miles: 138 genera are found to have winged seeds.

2. In some plants the seed-vessels open with violence when the seeds are ripe, and thus throw them to a considerable distance; and we have an enumeration of 50 genera whose seeds are thus dispersed.

3. Other seeds are furnished with hooks, by which, when ripe, they adhere to the coats of animals, and are carried by them to their lodging places. Linnæus reckons 50 genera armed in this manner.

4. Many seeds are dispersed by means of birds and other animals; who pick up the berries, and afterwards eject the seeds uninjured. Thus the fox disseminates the privet, and man many species of fruit. The plants found growing upon walls and houses, on the tops of high

Plants. high rocks, &c. are mostly brought there by birds; and it is universally known, that by manuring a field with new dung, innumerable weeds will spring up which did not exist there before: 193 species are reckoned up which may be disseminated in this manner.

5. The growth of other seeds is promoted by animals in a different way. While some are eaten, others are scattered and trodden into the ground by them. The squirrel gnaws the cones of the pine, and many of the seeds fall out. When the loxica eats off their bark, almost his only food, many of their seeds are committed to the earth, or mixed in the morass with moss, where he had retired. The glandularia, when she hides up her nuts, often forgets them, and they strike root. The same is observable of the walnut; mice collect and bury great quantities of them, and being afterwards killed by different animals, the nuts germinate.

6. We are astonished to find mosses, fungi, byssus, and mucor, growing everywhere; but it is for want of reflecting that their seeds are so minute that they are almost invisible to the naked eye. They float in the air like atoms, and are dropped everywhere, but grow only in those places where there was no vegetation before; and hence we find the same mosses in North America and in Europe.

7. Seeds are also dispersed by the ocean, and by rivers. "In Lapland (says Linnæus), we see the most evident proofs how far rivers contribute to deposite the seeds of plants. I have seen Alpine plants growing upon their shores frequently 36 miles distant from the Alps; for their seeds falling into the rivers, and being carried along and left by the stream, take root there.—We may gather likewise from many circumstances how much the sea furthers this business.—In Roslagia, the island of Græsœa, Oeland, Gothland, and the shores of Scania, there are many foreign and German plants not yet naturalized in Sweden. The centaury is a German plant, whose seeds being carried by the wind into the sea, the waves landed this foreigner upon the coasts of Sweden. I was astonished to see the veronica maritima, a German plant, growing at Tornea, which hitherto had been found only in Græsœa: the sea was the vehicle by which this plant was transported thither from Germany; or possibly it was brought from Germany to Græsœa, and from thence to Tornea. Many have imagined, but erroneously, that seed corrupts in water, and loses its principle of vegetation. Water at the bottom of the sea is seldom warm enough to destroy seeds; we have seen water cover the surface of a field for a whole winter, while the seed which it contained remained unhurt, unless at the beginning of spring the waters were let down so low by drains, that the warmth of the sunbeams reached to the bottom. Then the seeds germinate, but presently become putrescent; so that for the rest of the year the earth remains naked and barren.

Amœn. Academ.

Rain and showers carry seeds into the cracks of the earth, streams, and rivers; which last, conveying them to a distance from their native places, plant them in a foreign soil."

8. Lastly, some seeds assist their projection to a distance in a very surprising manner. The crupina, a species of centaury, has its seeds covered over with erect bristles, by whose assistance it creeps and moves about in such a manner, that it is by no means to be kept in the hand. If you confine one of them between the stocking and the foot, it creeps out either at the sleeve or neck-band, travelling over the whole body. If the bearded oat, after harvest, be left with other grain in the barn, it extricates itself from the glume; nor does it stop in its progress till it gets to the walls of the building. Hence, says Linnæus, the Dalecarlian, after he has cut and carried it into the barn, in a few days finds all the glumes empty, and the oats separate from them; for every oat has a spiral arista or beard annexed to it, which is contracted in wet, and extended in dry weather. When the spiral is contracted, it drags the oat along with it: the arista being bearded with minute hairs pointing downward, the grain necessarily follows it; but when it expands again, the oat does not go back to its former place, the roughness of the beard the contrary way preventing its return. If you take the seeds of equisetum, or fern, these being laid upon paper, and viewed in a microscope, will be seen to leap over any obstacle as if they had feet; by which they are separated and dispersed one from another; so that a person ignorant of this property would pronounce these seeds to be so many mites or small insects.

We cannot finish this article without remarking, that many ingenious men (A) believe that plants have a power of perception. Of this opinion we shall now give an account from the second volume of the Manchester Transactions, where we find some *speculations on the perceptive power of vegetables by Dr Percival*, who attempts to show, by the several analogies of organization, life, instinct, spontaneity, and self-motion, that plants, like animals, are endued with the powers both of perception and enjoyment. The attempt is ingenious, and is ingeniously supported, but in our opinion fails to convince. That there is an analogy between animals and vegetables is certain; but we cannot from thence conclude that they either perceive or enjoy. Botanists have, it is true, derived from *anatomy* and *physiology*, almost all the terms employed in the description of plants. But we cannot from thence conclude, that their organization, tho' it bears an analogy to that of animals, is the sign of *a living principle*, if to this *principle* we annex the idea of *perception*; yet so fully is our author convinced of the truth of it, that he does not think it extravagant to suppose, that, in some future period, perceptivity may be discovered to extend even beyond the limits now assigned to vegetable life. Corallines, madrepores, millepores, and spunges, were formerly considered as fossil bodies:

(A) The ingenious Dr Bell held this opinion, as appears from the close of his *Thesis de Physiologia Plantarum*, which was published at Edinburgh, June 1777, and a translation of which by Dr Currie we find in the second volume of the Manchester Transactions, where our readers will also find memoirs of its author. Dr Currie informs us, that Dr Hope, the late excellent professor of botany in Edinburgh, in his course of lectures, used to speak of Dr Bell with the highest esteem; but did not approve of the idea which he entertained respecting the feeling or perception of plants.

Plants. dies: but the experiments of Count Marſigli evinced, that they are endued with life, and led him to claſs them with the maritime plants. And the obſervations of Ellis, Juſſieu, and Peyſonel, have ſince raiſed them to the rank of animals. The detection of error, in long eſtabliſhed opinions concerning one branch of natural knowledge, juſtifies the ſuſpicion of its exiſtence in others, which are nearly allied to it. And it will appear from the proſecution of our inquiry into the inſtincts, ſpontaneity, and ſelf-moving power of vegetables, that the ſuſpicion is not without foundation.

He then goes on to draw a compariſon between the inſtincts of animals and thoſe of vegetables: the calf, as ſoon as it comes into the world, applies to the teats of the cow; and the duckling, though hatched under a hen, runs to the water.

"Inſtincts analogous to theſe (ſays our author), operate with equal energy on the vegetable tribe. A ſeed contains a germ, or plant in miniature, and a radicle, or little root, intended by nature to ſupply it with nouriſhment. If the ſeed be ſown in an inverted poſition, ſtill each part purſues its proper direction. The plumula turns upward, and the radicle ſtrikes downward into the ground. A hop-plant, turning round a pole, follows the courſe of the ſun, from ſouth to weſt, and ſoon dies, when forced into an oppoſite line of motion: but remove the obſtacle, and the plant will quickly return to its ordinary poſition. The branches of a honey-ſuckle ſhoot out longitudinally, till they become unable to bear their own weight; and then ſtrengthen themſelves, by changing their form into a ſpiral: when they meet with other living branches, of the ſame kind, they coaleſce, for mutual ſupport, and one ſpiral turns to the right and the other to the left; thus ſeeking, by an inſtinctive impulſe, ſome body on which to climb, and increaſing the probability of finding one by the diverſity of their courſe: for if the auxiliary branch be dead, the other uniformly winds itſelf round from the right to the left.

"Theſe examples of the inſtinctive economy of vegetables have been purpoſely taken from ſubjects familiar to our daily obſervation. But the plants of warmer climates, were we ſufficiently acquainted with them, would probably furniſh better illuſtrations of this acknowledged power of animality: and I ſhall briefly recite the hiſtory of a very curious exotic, which has been delivered to us from good authority; and confirmed by the obſervations of ſeveral European botaniſts." Plants.

The Doctor then goes on to give a deſcription of the *dionæa muſcipula* (B), for which ſee vol. vi. p. 32. and concludes, that if he has furniſhed any preſumptive proof of the inſtinctive power of vegetables, it will neceſſarily follow that they are endued with ſome degree of ſpontaneity. More fully to evince this, however, the Doctor points out a few of thoſe phenomena in the vegetable kingdom which ſeem to indicate ſpontaneity.—"Several years ago (ſays he), whilſt engaged in a courſe of experiments to aſcertain the influence of fixed air on vegetation, the following fact repeatedly occurred to me. A ſprig of mint, ſuſpended by the root, with the head downwards, in the middle glaſs veſſel of Dr Nooth's machine, continued to thrive vigorouſly, without any other pabulum than what was ſupplied by the ſtream of mephitic gas to which it was expoſed. In 24 hours the ſtem formed into a curve, the head became erect, and gradually aſcended towards the mouth of the veſſel; thus producing, by ſucceſſive efforts, a new and unuſual configuration of its parts. Such exertions in the ſprig of mint, to rectify its inverted poſition, and to remove from a foreign to its natural element, ſeems to evince evolition to avoid what was evil, and to recover what had been experienced to be good. If a plant, in a garden-pot, be placed in a room which has no light except from a hole in the wall, it will ſhoot towards the hole, paſs through it into the open air, and then vegetate upwards in its proper direction. Lord Kames relates, that, 'amongſt the ruins of New Abbey, formerly a monaſtery in Galloway, there grows on the top of a wall a plane tree, 20 feet high. Straitened for nouriſhment in that barren ſituation, it ſeveral years ago directed roots down the ſide of the wall till they reached the ground ten feet below: and now the nouriſhment it afforded to theſe roots, during the time of deſcending, is amply repaid; having every year ſince that time made vigorous ſhoots. From the top of the wall to the ſurface of the earth, theſe roots have not thrown out a ſimple fibre, but are now united into a pretty thick hard root.

"The regular movements by which the ſun-flower preſents its ſplendid diſk to the ſun have been known to naturaliſts,

(B) Dr Watſon, the preſent biſhop of Landaff, who has eſpouſed the ſame ſide of the queſtion with Dr Percival (ſee the 5th vol. of his *Chemical Eſſays*), reaſons thus on the motions of vegetables. "Whatever can produce any effect (ſays he) upon an animal organ as the impact of external bodies, heat and cold, the vapour of burning ſulphur, of volatile alkali, want of air, &c. are found to act alſo upon the plants called *ſenſitive*. But not to inſiſt upon any more inſtances, the muſcular motions of the dionæa muſcipula lately brought into Europe from America, ſeem far ſuperior in quickneſs to thoſe of a variety of animals. Now to refer the muſcular motions of ſhell-fiſh and zoophytes to an internal principle of volition, to make them indicative of the perceptivity of the being, and to attribute the more notable ones of vegetables to certain mechanical dilatations and contractions of parts occaſioned by external impulſe, is to err againſt that rule of philoſophizing which aſſigns the ſame cauſes for effects of the ſame kind. The motions in both caſes are equally accommodated to the preſervation of the being to which they belong, are equally diſtinct and uniform, and ſhould be equally derived from mechaniſm, or equally admitted as criterions of perception.

"I am ſenſible that theſe and other ſimilar motions of vegetables may by ſome be conſidered as analogous to the automatic or involuntary motions of animals; but as it is not yet determined amongſt the phyſiologiſts, whether the motion of the heart, the periſtaltic motion of the bowels, the contractions obſervable upon external impulſe in the muſcles of animals deprived of their heads and hearts, be attributable to an irritability unaccompanied with perceptivity, or to an uneaſy ſenſation, there ſeems to be no reaſon for entering into ſo obſcure a diſquiſition; eſpecially ſince irritability, if admitted as the cauſe of the motions of vegetables, muſt *a fortiori* be admitted as the cauſe of the leſs exquiſite and diſcernible motions of beings univerſally referred to the animal kingdom."

naturalists, and celebrated by poets, both of ancient and modern times. Ovid founds upon it a beautiful story; and Thomson describes it as an attachment of love to the celestial luminary.

> 'But one, the lofty follower of the sun,
> 'Sad when he sets, shuts up her yellow leaves,
> 'Drooping all night; and when he warm returns,
> 'Points her enamour'd bosom to his ray.'
>
> SUMMER, line 216.

Dr Percival next touches on motion; he mentions corallines, seapens‡, oysters, &c as endued with the power of motion in a very small degree, and then he speaks in the following manner. "Mr Miller (says he), in his late account of the island of Sumatra, mentions a species of coral, which the inhabitants have mistaken for a plant, and have denominated it *lalan-cout*, or sea-grass. It is found in shallow bays, where it appears like a straight stick, but when touched withdraws itself into the sand. Now if self-moving faculties like these indicate animality, can such a distinction be denied to vegetables, possessed of them in an equal or superior degree? The water-lily, be the pond deep or shallow in which it grows, pushes up its flower-stems till they reach the open air, that the farina fecundans may perform without injury its proper office. About seven in the morning the stalk erects itself, and the flowers rise above the surface of the water: in this state they continue till four in the afternoon, when the stalk becomes relaxed, and the flowers sink and close. The motions of the sensitive plant have been long noticed with admiration, as exhibiting the most obvious signs of perceptivity. And if we admit such motions as criteria of a like power in other beings, to attribute them in this instance to mere mechanism, actuated solely by external impulse, is to deviate from the soundest rule of philosophizing, which directs us not to multiply causes when the effects appear to be the same. Neither will the laws of electricity better solve the phenomena of this animated vegetable: for its leaves are equally affected by the contact of electric and non-electric bodies; show no change in their sensibility whether the atmosphere be dry or moist; and instantly close when the vapour of volatile alkali or the fumes of burning sulphur are applied to them. The powers of chemical stimuli to produce contractions in the fibres of this plant may perhaps lead some philosophers to refer them to the *vis insita*, or irritability, which they assign to certain parts of organized matter, totally distinct from, and independent of, any sentient energy. But the hypothesis is evidently a solecism, and refutes itself. For the presence of irritability can only be proved by the experience of irritations, and the idea of irritation involves in it that of feeling.

‡ See *Pennatula, Ostrea, Mytilus*, &c.

"But there is a species of the order of decandria, which constantly and uniformly exerts a self-moving power, uninfluenced either by chemical stimuli, or by any external impulse whatsoever. This curious shrub, which was unknown to Linnæus, is a native of the East Indies, but has been cultivated in several botanical gardens here. I had an opportunity of examining it in the collection of the late Dr Brown. See HEDYSARUM.—I cannot better comment on this wonderful degree of vegetable animation than in the words of Cicero. *Inanimum est omne quod pulsu agitatur externo; quod autem est animal, id motu cietur interiore et suo.*

"I have thus attempted, with the brevity prescribed by the laws of this society, to extend our views of animated nature; to gratify the mind with the contemplation of multiplied accessions to the general aggregate of felicity; and to exalt our conceptions of the wisdom, power, and benificence of God. In an undertaking never yet accomplished, disappointment can be no disgrace: in one directed to such noble objects, the motives are a justification, independently of success. Truth, indeed, obliges me to acknowledge, that I review my speculations with much diffidence; and that I dare not presume to expect they will produce any permanent conviction in others, because I experience an instability of opinion in myself. For, to use the language of Tully, *Nescio quomodo, dum lego, assentior; cum posui librum, assensio omnis illa elabitur.*—But this scepticism is perhaps to be ascribed to the influence of habitual preconceptions, rather than to a deficiency of reasonable proof. For besides the various arguments which have been advanced in favour of vegetable perceptivity, it may be further urged, that the hypothesis recommends itself by its consonance to those higher analogies of nature, which lead us to conclude, that the greatest possible sum of happiness exists in the universe. The bottom of the ocean is overspread with plants of the most luxuriant magnitude. Immense regions of the earth are covered with perennial forests. Nor are the Alps, or the Andes, destitute of herbage, though buried in deeps of snow. And can it be imagined that such profusion of life subsists without the least sensation or enjoyment? Let us rather, with humble reverence, suppose, that vegetables participate, in some low degree, of the common allotment of vitality; and that our great Creator hath apportioned good to all living things, 'in number, weight, and measure." See *SENSITIVE Plant*, MIMOSA, *DIONÆA Muscipula, Vegetable MOTION, &c.*

To these ingenious and spirited observations, we shall subjoin nothing of our own, but leave our readers to determine for themselves (c). Speculations of this kind, when carried on by sober men, will never be productive of bad consequences; but by the subtle sceptic, or the more unwary inquirer, they may be made the engine of very dangerous errors. By this we do not mean to insinuate

(c) In the 2d volume of *Transactions of the Linnæan Society*, we find Dr Percival's reasoning very ably combated, as far as he draws his consequences from the external motions of plants; where it is argued, that these motions, though in some respects similar to those of animals, can and ought to be explained, without concluding that they are endowed either with perception or volition. Mr Townson concludes his paper in these words: "When all is considered (says he), I think we shall place this opinion amongst the many ingenious flights of the imagination, and soberly follow that blind impulse which leads us naturally to give sensation and perceptivity to animal life, and to deny it to vegetables; and so still say with Aristotle, and our great master Linnæus, *Vegetabilia crescunt & vivunt; animalia crescunt, vivunt, & sentiunt.*"

Plants.

finuate that the fpirit of inquiry fhould be fuppreffed, becaufe that fpirit, in the hands of weak or of wicked men, may be abufed. By thofe, however, who know the bad confequences that may be drawn, and indeed that have been drawn, from the opinions we have now given an account of, our caution will not be deemed impertinent. See PHYSIOLOGY *paffim*, and particularly n° 42, and note (A), p. 678.

PLANTS growing on Animals. See *INSECTS giving root to Plants*.

Sexes of PLANTS. See SEXES, and BOTANY, fect. v.

Colours of PLANTS. See *COLOUR of Plants*.

Colours extracted from PLANTS. See *COLOUR-making*, n° 35, *et feq.*

Method of Drying and Preferving PLANTS for Botanifts.—Many methods have been devifed for the prefervation of plants: we fhall relate only thofe that have been found moft fuccefsful.

Withering's Botanical Arrangement, Introd. p. 48.

Firft prepare a prefs, which a workman will make by the following directions. Take two planks of a wood not liable to warp. The planks muft be two inches thick, 18 inches long, and 12 inches broad. Get four male and four female fcrews, fuch as are commonly ufed for fecuring fafh-windows. Let the four female fcrews be let into the four corners of one of the planks, and correfponding holes made through the four corners of the other plank for the male fcrews to pafs through, fo as to allow the two planks to be fcrewed tightly together. It will not be amifs to face the bearing of the male fcrews upon the wood with iron plates; and if the iron plates went acrofs from corner to corner of the wood, it would be a good fecurity againft the warping.

Secondly, get half a dozen quires of large foft fpongy paper (fuch as the ftationers call *bloffom blotting paper* is the beft), and a few fheets of ftrong pafteboard.

The plants you wifh to preferve fhould be gathered in a dry day, after the fun hath exhaled the dew; taking particular care to collect them in that ftate wherein their generic and fpecific characters are moft confpicuous. Carry them home in a tin-box nine inches long, four inches and a half wide, and one inch and a half deep. Get the box made of the thinneft tinned iron that can be procured; and let the lid open upon hinges. If any thing happens to prevent the immediate ufe of the fpecimens you have collected, they will be kept frefh two or three days in this box much better than by putting them in water. When you are going to preferve them, fuffer them to lie upon a table until they become limber; and then they fhould be laid upon a pafteboard, as much as poffible in their natural form, but at the fame time with a particular view to their generic and fpecific characters. For this purpofe it will be advifable to feparate one of the flowers, and to difplay the generic character. If the fpecific character depends upon the flower or upon the root, a particular difplay of that will be likewife neceffary. When the plant is thus difpofed upon the pafteboard, cover it with eight or ten layers of fpongy paper, and put it into the prefs. Exert only a fmall degree of preffure for the firft two or three days; then examine it, unfold any unnatural plaits, rectify any miftakes, and, after putting frefh paper over it, fcrew the prefs harder. In about three days more feparate the plant from the pafteboard, if it is fufficiently firm to allow of a change of place; put it upon a frefh pafteboard, and, covering it with frefh bloffom-paper, let it remain in the prefs a few days longer. The prefs fhould ftand in the fun-fhine, or within the influence of a fire.

When it is perfectly dry, the ufual method is to faften it down, with pafte or gum-water, on the right-hand inner page of a fheet of large ftrong writing-paper. It requires fome dexterity to glue the plant neatly down, fo that none of the gum or pafte may appear to defile the paper. Prefs it gently again for a day or two, with a half fheet of bloffom-paper betwixt the folds of the writing-paper. When it is quite dry, write upon the left-hand inner page of the paper the name of the plant; the fpecific character; the place where, and the time when, it was found; and any other remarks you may think proper. Upon the back of the fame page, near the fold of the paper, write the name of the plant, and then place it in your cabinet. A fmall quantity of finely powdered arfenic, or corrofive fublimate, is ufually mixed with the pafte or gum-water, to prevent the devaftations of infects; but the feeds of ftaves-acre finely powdered will anfwer the fame purpofe, without being liable to corrode or to change the colour of the more delicate plants. Some people put the dried plants into the fheets of writing paper, without faftening them down at all; and others only faften them by means of fmall flips of paper, pafted acrofs the ftem or branches. Where the fpecies of any genus are numerous, and the fpecimens are fmall, feveral of them may be put into one fheet of paper.

Another more expeditious method is to take the plants out of the prefs after the firft or fecond day; let them remain upon the pafteboard; cover them with five or fix leaves of bloffom paper, and iron them with a hot fmoothing iron until they are perfectly dry. If the iron is too hot, it will change the colours; but fome people, taught by long practice, will fucceed very happily. This is quite the beft method to treat the orchis and other flimy mucilaginous plants.

Another method is to take the plants when frefh gathered, and, inftead of putting them into the prefs, immediately to faften them down to the paper with ftrong gum water: then dip a camel-hair pencil into fpirit-varnifh, and varnifh the whole furface of the plant two or three times over. This method fucceeds very well with plants that are readily laid flat, and it preferves their colours better than any other. The fpirit varnifh is made thus. To a quart of highly rectified fpirit of wine put five ounces of gum fandarach; two ounces of maftich in drops; one ounce of pale gum elemi, and one ounce of oil of fpike-lavender. Let it ftand in a warm place, and fhake it frequently to expedite the folution of the gums.

Where no better convenience can be had, the fpecimens may be difpofed fyftematically in a large folio book; but a vegetable cabinet is upon all accounts more eligible. In Plate CCCXCVII. there is a fection of a cabinet, in the true proportions it ought to be made, for containing a complete collection of Britifh plants. By the affiftance of this drawing, and the adjoining fcale, a workman will readily make one. The drawers muft have backs and fides, but no other front than a fmall

Plants.

small ledge. Each drawer will be 14 inches wide, and 10 inches from the back to the front, after allowing half an inch for the thickness of the two sides, and a quarter of an inch for the thickness of the back. The sides of the drawers, in the part next the front, must be sloped off in a serpentine line, something like what the workmen call an *ogee*. The bottoms of the drawers must be made to slide in grooves cut in the uprights, so that no space may be lost betwixt drawer and drawer. After allowing a quarter of an inch for the thickness of the bottom of each drawer, the clear perpendicular space in each must be as in the following table.

I. Two tenths of an inch.
II. One inch and two-tenths.
III. Four inch, and six tenths.
IV. Two inches and three-tenths.
V. Seven inches and eight tenths.
VI. Two inches and two-tenths.
VII. Two tenths of an inch.
VIII. One inch and four-tenths.
IX. Two-tenths of an inch.
X. Two inches and eight-tenths.
XI. One inch and two-tenths.
XII. Three inches and five-tenths.
XIII. Two inches and four-tenths.
XIV. Three inches and eight tenths.
XV. Three inches and four tenths.
XVI. One inch and three tenths.
XVII. Two inches and eight tenths.
XVIII. Six tenths of an inch.
XIX. Ten inches
XX. One inch and nine-tenths.
XXI. Four inches and four tenths.
XXII. Two inches and six-tenths.
XXIII. One inch and two-tenths.
XXIV. Seventeen inches.

This cabinet shuts up with two doors in front; and the whole may stand upon a base, containing a few drawers for the reception of duplicates and papers.

Fossil Plants. Many species of tender and herbaceous plants are found at this day, in great abundance, buried at considerable depths in the earth, and converted, as it were, into the nature of the matter they lie among; fossil wood is often found very little altered, and often impregnated with substances of almost all the different fossil kinds, and lodged in all the several strata, sometimes firmly imbedded in hard matter; sometimes loose: but this is by no means the case with the tenderer and more delicate subjects of the vegetable world. These are usually immersed either in a blackish slaty substance, found lying over the strata of coal, else in loose nodules of ferruginous matter of a pebble-like form, and they are always altered into the nature of the substance they lie among: what we meet with of these are principally of the fern kind; and what is very singular, though a very certain truth, is, that these are principally the ferns of American growth, not those of our own climate. The most frequent fossil plants are the polypody, spleenwort, osmund, trichomanes, and the several larger and smaller ferns; but besides these there are also found pieces of the equisetum or horse-tail, and joints of the stellated plants, as the clivers, madder, and the like; and these have been too often mistaken for flowers; sometimes there are also found complete grasses, or parts of them, as also reeds, and other watery plants; sometimes the ears of corn, and not unfrequently the twigs or bark, and impressions of the bark, and fruit of the pine or fir kind, which have been, from their scaly appearance, mistaken for the skins of fishes; and sometimes, but that very rarely, we meet with mosses and sea-plants.

Many of the ferns not unfrequently found, are of very singular kinds, and some species yet unknown to us; and the leaves of some appear set at regular distances, with round protuberances and cavities. The stones which contain these plants split readily, and are often found to contain, on one side, the impression of the plant, and on the other the prominent plant itself: and, beside all that have been mentioned, there have been frequently supposed to have been found with us ears of common wheat, and of the maize or Indian corn; the first being in reality no other than the common endmost branches of the firs, and the other the thicker boughs of various species of that and of the pine kind, with their leaves fallen off; such branches in such a state cannot but afford many irregular tubercles and papillæ, and, in some species, such as are more regularly disposed.

These are the kinds most obvious in England; and these are either immersed in the slaty stone which constitutes whole strata, or in flatted nodules, usually of about three inches broad, which readily split into two pieces on being struck.

They are most common in Kent, on coal-pits near Newcastle, and the forest of Dean in Gloucestershire; but are more or less found about almost all our coal-pits, and many of our iron mines. Though these seem the only species of plants found with us, yet in Germany there are many others, and those found in different substances. A whitish stone, a little harder than chalk, frequently contains them: they are found also often in a grey slaty stone of a firmer texture, not unfrequently in a blackish one, and at times in many others. Nor are the bodies themselves less various here than the matter in which they are contained: the leaves of trees are found in great abundance, among which those of the willow, poplar, whitethorn, and pear trees, are the most common; small branches of box, leaves of the olive-tree, and stalks of garden thyme, are also found there; and sometimes ears of the various species of corn, and the larger as well as the smaller mosses in great abundance.

These seem the tender vegetables, or herbaceous plants, certainly found thus immersed in hard stone, and buried at great depths in the earth: others of many kinds there are also named by authors; but as in bodies so imperfect errors are easily fallen into, these seem all that can be ascertained beyond mere conjecture.

Plants, *method of preserving them in their original shape and colour*. Wash a sufficient quantity of fine sand, so as perfectly to separate it from all other substances; dry it; pass it through a sieve to clear it from any gross particles which would not rise in the washing: take an earthen vessel of a proper size and form, for every plant and flower which you intend to preserve; gather your plants and flowers when they are in a state of perfection, and in dry weather, and always with a convenient portion of the stalk: heat a little of the dry sand prepared as above, and lay it in the bottom of the vessel, so as equally to cover it; lay the plant or flower upon it, so as that no part of it may touch the sides of the vessel: sift or shake in more of the same sand by little upon it, so that the leaves may be extended by degrees, and without injury, till the plant or flower is covered about two inches thick: put the vessel into a stove, or hot-house, heated by little and little to the 50th degree; let it

ſtand there a day or two, or perhaps more, according to the thickneſs and ſucculence of the flower or plant; then gently ſhake the ſand out upon a ſheet of paper, and take out the plant, which you will find in all its beauty, the ſhape as elegant, and the colour as vivid as when it grew.

Some flowers require certain little operations to preſerve the adherence of their petals, particularly the tulip; with reſpect to which it is neceſſary, before it is buried in the ſand, to cut the triangular fruit which riſes in the middle of the flower; for the petals will then remain more firmly attached to the ſtalk.

A hortus ſiccus prepared in this manner would be one of the moſt beautiful and uſeful curioſities that can be.

Moving PLANT. See HEDYSARUM.

Sea PLANTS. See *Sea Plants*.

Senſitive PLANT. See MIMOSA and *Senſitive Plant*.

PLANT-*Lice*, *Vine-fretters*, or *Pucerons*. See APHIS.

PLANTA, a PLANT. See PLANT.

PLANTA *Fœminea*, a female plant, is one which bears female flowers only. It is oppoſed to a *male* plant, which bears only male flowers; and to an *androgynous* one, which bears flowers of both ſexes.—Female plants are produced from the ſame ſeed with the male, and arrange themſelves under the claſs of diœcia in the ſexual method.

PLANTAGENET, the ſurname of the kings of England from Henry II. to Richard III. incluſive. Antiquarians are much at a loſs to account for the origin of this name; and the beſt derivation they can find for it is, that Fulk, the firſt earl of Anjou of that name, being ſtung with remorſe for ſome wicked action, went in pilgrimage to Jeruſalem as a work of atonement; where, being ſoundly ſcourged with broom twigs, which grew plentifully on the ſpot, he ever after took the ſurname of *Plantagenet* or *broomſtalk*, which was retained by his noble poſterity.

PLANTAGO, PLANTAIN; a genus of the monogynia order, belonging to the tetrandria claſs of plants. To this genus Linnæus has joined the coronopus and pſyllium of Tournefort. The firſt of theſe is called *hartſhorn*, the latter *fleawort*. Of theſe there are ſeveral diſtinct ſpecies, and ſome varieties; but as they are rarely cultivated in gardens, we ſhall not enumerate them here, and ſhall only mention ſuch of them as grow naturally in Britain. Of the plantain there are the following ſorts: The common broad-leaved plantain, called *waybread;* the great hoary plantain, or lambs-tongue; the narrow-leaved plantain, or ribwort: and the following varieties have alſo been found in England, which are accidental; the beſom-plantain and roſe-plantain. The plantains grow naturally in paſtures in moſt parts of England, and are frequently very troubleſome weeds. The common plantain and ribwort plantain are both uſed in medicine, and are ſo well known as to need no deſcription. They are ſaid to be ſlightly aſtringent; and the green leaves are commonly applied to freſh wounds by the common people.

Of the coronopus, or buckſhorn plantain, there are two varieties growing in England, viz. the common buckſhorn, which grows plentifully on heaths everywhere; and the narrow-leaved Welch ſort, which is found upon many of the Welch mountains. The firſt of theſe was formerly cultivated as a ſalad herb in gardens, but has been long baniſhed from thence for its rank diſagreeable flavour; it is ſometimes uſed in medicine.—There has been one ſpecies of pſyllium or fleawort found growing naturally in England, which is uſed in medicine. It was found in the earth thrown out of the bottom of the canals which were dug for the Chelſea waterworks, where it grew in great plenty. The ſeeds of it muſt have been buried there ſome ages; for no perſon remembers any of the plants growing in that neighbourhood before. The ſeeds of this ſpecies are ſometimes uſed, as they are imported from the ſouth of France.

PLANTAIN. See PLANTAGO.

PLANTAIN-*Tree*. See MUSA.

PLANTATION, in the Weſt Indies, denotes a ſpot of ground which a planter, or perſon arrived in a new colony, pitches on to cultivate for his own uſe, or is aſſigned for that purpoſe. However, the term *plantation* is often uſed in a term ſynonymous with colony. See COLONY.

PLANTERSHIP, in a general ſenſe, the buſineſs of a planter.

PLANTERSHIP, in the Weſt Indies, denotes the management of a ſugar plantation, including not only the cultivation of the cane, but the various proceſſes for the extraction of the ſugar, together with the making of ſugar-ſpirits. See RUM, SACCHARUM, and SUGAR.

To effect a deſign ſo comprehenſive, it is neceſſary for a planter to underſtand every branch of the art preciſely, and to uſe the utmoſt attention and caution both in the laying down and executing of his plans. It is therefore the duty of a good planter to inſpect every part of his plantation with his own eyes; to place his proviſions, ſtores, and utenſils, in regular order, and in ſafe repoſitories; that by preſerving them in perfection, all kinds of waſte may be prevented.

But as negroes, cattle, mules, and horſes, are as it were the nerves of a ſugar-plantation, it is expedient to treat that ſubject with ſome accuracy.

Of Negroes, Cattle, &c.] In the firſt place, then, as it is the intereſt of every planter to preſerve his negroes in health and ſtrength; ſo every act of cruelty is not leſs repugnant to the maſter's real profit, than it is contrary to the laws of humanity: and if a manager conſiders his own eaſe and his employer's intereſt, he will treat all negroes under his care with due benevolence; for good diſcipline is by no means inconſiſtent with humanity: on the contrary, it is evident from experience, that he who feeds his negroes well, proportions their labour to their age, ſex, and ſtrength, and treats them with kindneſs and good nature, will reap a much larger product, and with infinitely more eaſe and ſelf-ſatisfaction, than the moſt cruel taſkmaſter, who ſtarves his negroes, or chaſtiſes them with undue ſeverity. Every planter then who wiſhes to grow rich with eaſe, muſt be a good economiſt; muſt feed his negroes with the moſt wholeſome food, ſufficient to preſerve them in health and vigour. Common experience points out the methods by which a planter may preſerve his people in health and ſtrength. Some of his moſt fruitful land ſhould be allotted to each negro in proportion to his family, and a ſufficient portion of time allowed for the cultivation of it; but becauſe ſuch allotment cannot in long droughts produce enough for his comfortable ſupport, it is the incumbent duty

Martin on Plantership.

Planter-ship. duty of a good planter to have always his stores well filled with Guinea corn, yams, or eddoes, besides potatoes growing in regular succession: for plenty begets cheerfulness of heart, as well as strength of body; by which more work is effected in a day by the same hands than in a week when enervated by want and severity. Scanty meals may sustain life; but it is evident, that more is requisite to enable a negro or any other person to go through the necessary labours. He, therefore, who will reap plentifully, must plant great abundance of provisions as well as sugar-canes; and it is nature's economy so to fructify the soil by the growth of yams, plantains, and potatoes, as to yield better harvests of sugar, by that very means, than can be produced by many other arts of cultivation. Plantains are the principal support of all the negroes in Jamaica; and are also much cultivated, at great expence of manure, in Barbadoes; but ought not to be solely depended upon in climates subject to hurricanes. A celebrated planter and economist of the last mentioned island, who raised an immense fortune from very small beginnings only by planting, affirmed, that he fed constantly at least 300 negroes out of 12 acres of plantains. How that excellent produce came to be so long neglected in some of the islands it is hard to guess; but at present the neglect seems to be founded upon a vulgar error, that plantains cannot thrive in any other than low moist soils. In such places, no doubt, they flourish most luxuriantly; but yet they thrive and bear fruit abundantly on mountains and in marshes, and in the driest black mould upon marle or rocks, and even in sharp gravelly soils, as may be evinced by numberless instances.

However plenty of wholesome food may be conducive to health, there are also other means, equally necessary to strength and the longevity of negroes, well worth the planter's attention: and those are, to choose airy dry situations for their houses; and to observe frequently that they be kept clean, in good repair, and perfectly water-tight; for nastiness, and the inclemencies of weather, generate the most malignant diseases. If these houses are situated also in regular order, and at due distances, the spaces may at once prevent general devastations by fire, and furnish plenty of fruits and pot-herbs, to please an unvitiated palate, and to purify the blood. Thus then ought every planter to treat his negroes with tenderness and generosity, that they may be induced to love and obey him out of mere gratitude, and become real good beings by the imitation of his behaviour; and therefore a good planter, for his own ease and happiness, will be careful of setting a good example.

Having thus hinted the duties of a planter to his negroes, let the next care be of cattle, mules, and horses. The planters of Barbadoes (who are perhaps the most skilful of all others, and exact to a nicety in calculations of profit and loss), are, with respect to their cattle, the most remiss of any in all the islands; as if the carriage of canes to the mill, and of plantation-produce to the market, was not as essential as any other branch of plantership. At Barbadoes, in particular, the care of these animals is of more importance; because the soil, worn out by long culture, cannot yield any produce without plenty of dung. Some planters are nevertheless so ingeniously thrifty, as to carry their canes upon negroes heads; acting in that respect diametrically opposite to their own apparent interest, which cannot be served more effectually than by saving the labour of human hands, in all cases where the labour of brutes can be substituted; and for that end, no means of preserving those creatures in health and strength ought to be neglected.

Planter-ship. The first care therefore is to provide plenty and variety of food. In crop-time, profusion of cane-tops may be had for the labour of carriage; but they will be more wholesome and nutritious if tedded like hay by the sun's heat, and sweated by laying them in heaps a few days before they are eaten. In this season of abundance, great ricks of cane-tops (the butt ends turned inwards) should be made in the most convenient corner of each field, to supply the want of pasturage and other food: and these are very wholesome if chopped into small parts, and mixed sometimes with common salt or sprinkled with melasses mixed with water: but yet the cattle require change of food to preserve them in strength; such as Guinea corn, and a variety of grass, which every soil produces with a little care in moist weather; and indeed this variety is found necessary in all climes.

But since that variety is not to be had during those severe droughts to which hot climates are liable, and much less in those small islands which cannot furnish large tracts of meadow-lands for hay, the only resource is the fodder of cane-tops or tedded Guinea-corn leaves; which are very nutritious, and may be preserved in perfection for more than a whole year, provided the tops or Guinea-corn are well tedded for three or four hot days as they lie spread in the field; and then, being tied into bundles or sheaves, must lie in the hot sun for three or four days more, when they may be fit to be put up into ricks. The best method of making them is in an oblong figure, about 30 feet in length, and 16 or 18 feet wide; seven feet high at the sides, and from thence sloping like the roof of an house, the ridge of which must be thatched very carefully; for the sides may be secured from wet by placing the bundles with the butts upwards towards the ridge, in courses, and lapping the upper over the lower course.

The best method of forming those ricks is to place the first course of bundles all over the base one way; the second course reversely; and so alternately till the rick be finished.

When cattle are to be fed with this fodder, it must be observed to take down the bundles from the top, at the west end of the rick, to the bottom; for all these ricks must stand east and west lengthwise, as well to secure them from being overturned by high winds, as for the convenience of preserving them from wet, which cannot be done when ricks are made round. By this husbandry, an herd of cattle may be kept in strength, either in severe droughts, or in wet seasons when grass is purgative; and thus the necessity or expence of large pastures may be totally saved. The hay-knife used in England for cutting hay, answers for cutting ricks of tops.

The method of tedding Guinea-corn to make a kind of hay, will require a little explanation here. When Guinea corn is planted in May, and to be cut down in July, in order to bear seed that year, that cutting, tedded properly, will make an excellent hay, which cattle prefer to meadow-hay. In like manner, after Guinea-corn has done bearing seed, the after crop will furnish a

Plantership.

great abundance of that kind of fodder which will keep well in ricks for two or three years.

The next care of a planter is to provide ſhade for his cattle; either by trees where they are fed in the heat of the day, if his ſoil requires not dung; or by building a flat ſhade over the pen where cattle are confined for making it. That ſuch ſhades are eſſentially neceſſary to the well-being of all animals in hot weather, is apparent to every common obſerver, who cannot fail of ſeeing each creature forſaking the moſt luxuriant paſtures in the heat of the day for the ſake of ſhade; thus convincing the owners, by inſtinctive argument, that ſhade is almoſt as neceſſary to the well-being of the brute creatures as food. Yet, notwithſtanding that demonſtration from the unerring courſe of nature, throughout all our iſlands (except in a very few inſtances), theſe poor creatures are expoſed to the ſcorching ſun-beams without mercy. Such inhuman neglect is not always ſo much the effect of inattention as of a miſtaken notion that ſhades are impedimental to the making of much dung; but a flat ſhade, covered with cane-traſh, may be ſo made as to let rain paſs through it without admiſſion of ſun-beams. This will do for cattle; but mules, which are ſpirited creatures, and work themſelves by draught into a foaming heat, ſhould be put into a warm ſtable, until quite cool: for turning them looſe to paſture when ſo hot, is probably the cauſe of their deſtruction by the glanders.

If the care of providing ſhade for brute creatures is ſo much the duty and intereſt of their owners, how much more is it agreeable to the laws of humanity to provide ſhade for human creatures travelling upon the high-roads in this hot climate? Nothing ſurely of ſo much beauty coſts ſo little expence as planting cocoa-nut or ſpreading timber trees in avenues along the highways, if each proprietor of the lands adjoining hath any taſte of elegance, or feeling for other men: but both thoſe kinds of trees will yield alſo great profit to the proprietor, by furniſhing him with timber, when perhaps not otherwiſe to be had; or with a delicious milk, fitted by nature to cool the effervefcence of the blood in this hot region; and alſo to improve the ſpirits made from ſugar to the delicacy and ſoftneſs of arrack. Cocoa-nut and cabbage-trees are both very beautiful and ſhady, bearing round heads of great expanſion, upon natural trunks or pillars of elegant proportion, and of ſuch an height as to furniſh a large ſhade, with a free circulation of air equally refreſhing to man and beaſt.

The common objection of injury to canes by the roots of ſuch trees growing on their borders, may be eaſily removed by digging a ſmall trench between the canes and trees, which may intercept their roots, and oblige them to ſeek ſuſtenance in the common road. Let it alſo be conſidered, beſides the benefits above ſuggeſted, that the planter will thus beautify his eſtate to the reſemblance of a moſt ſumptuous garden. And probably that very beauty might not only render the iſlands more healthful to the inhabitants, by preſerving them from fevers kindled by the burning ſun-beams, but alſo much more fruitful by making the weather more ſeaſonable: for as, by cutting down all its woods, an hot country becomes more ſubject to exceſſive droughts; ſo, by replanting it in the manner above deſcribed, this inconvenience would probably be prevented.

Let then the planter be kind not only to his fellow-creatures but merciful to his beaſts; giving them plenty and variety of wholeſome food, clear water, cool ſhade, and a clean bed, bleeding them after a long courſe of hard labour, currying their hides from filth and ticks (A); affording them ſalt and other phyſic when neceſſary; protecting them from the flaying rope-laſhes of a cruel driver (who needs no other inſtrument than a goad); proportioning their labour to their ſtrength; and by every art rendering their work as eaſy as poſſible. The general management of planters is not, perhaps, more defective in any other reſpect than in this: for, by pairing the cattle unequally, and by the drivers ill conduct in writhing to the right and left, the poor creatures are fatigued by much needleſs labour. An horſe ought therefore to be harneſſed before them as a leader. This docile creature, by being led in a ſtraight line, will ſoon learn to be an unerring guide, and the cattle will follow in the ſame direction with united ſtrength, and conſequently with more effect and leſs fatigue to each individual.

The Portugueſe of Madeira, by their poverty and ſcantineſs of paſture, breed the ſmalleſt kind of cattle; and yet one yoke of them will draw a much greater weight than a pair of our largeſt oxen, ſolely by an equal exertion of their joint ſtrength. That equality or evenneſs of draught is preſerved by boring gimblet holes through their horns, within two inches of the points, and running a thong of leather through thoſe holes, ſo as to tie the horns of each pair at ſix inches diſtance from each other. By this ligature the pair of cattle are abſolutely hindered from turning different ways, and draw in an even direction with united force. Thus it appears evidently from reaſon, as well as from experience, that the labour of our beaſts may, by a little contrivance, be rendered more eaſy and effectual.

Of the Culture of various Soils.] In the Britiſh ſugar-colonies there is as great a variety of ſoils as in any country of Europe; ſome naturally very rich or fruitful, yielding a luxuriant product with little labour or culture. This fruitful ſoil is of three kinds: a looſe hazel mould mixed with ſand, like that of St Chriſtopher's, and is the beſt in the known world for producing ſugar in great quantity, and of the beſt quality. The brick mould of Jamaica is ſomewhat of the ſame nature, and next in value; and then the various mixtures of mould and gravel, to be found in veins or plats over all the other iſlands. When any of theſe ſoils are exhauſted of their fertility by long and injudicious culture, they may be reſtored by any kind of dung well rotted; for theſe (B) warm ſoils cannot bear hot unrotten dung, without being laid fallow for a conſiderable

(A) One pound of native ſulphur, a quart of lamp-oil, and the like quantity of hog's-lard, intimately mixed and made into an ointment, is a cure for the mange, lice, &c.

(B) Theſe ſoils, which are naturally looſe and upon marle, Mr Martin calls *hot ſoils*; and theſe, he ſays, have been

Planter-ship.

able time after it. Another improvement is by sea-sand or sea-weed; or by digging in the cane-trash into steep lands, and by letting it lie to rot for some months. A third method is, by ploughing and laying it fallow; and the fourth method (the best of all), is by folding the fallows by sheep. But this can be practised only where there are extensive pastures; nor can the plough be employed where the soil abounds with large stones. In that case, however, the former method of digging in trash will be nearly as effectual, though more expensive, by hand-labour or hoe-ploughing.

The next best soil for producing good sugar is a mould upon clay, which if shallow requires much culture and good labour, or its produce will be small in quantity, though of a strong grain and bright colour, so as to yield most profit to the refiner of any sugar, except that produced from an hazel or gravelly soil, as before-mentioned. All the black-mould soils upon marle are generally fruitful, and will take any kind of dung; but yield not so strong or large-grained sugar. Marle, however, of a white, yellow, or blue colour, or rich mould from washes, or ashes of every kind, are excellent for every strong soil, as the chief ingredient in the compost of dung: either of them will do alone for stiff lands; but the yellow and chocolate marle are the most soapy, and the richest kind of manure (except fine mould) for all stiff lands. If these are well opened, pulverized by culture, and mixed with hot dung, or any kind of loose earth or marle, they will produce as plentifully as lighter soils: and all kinds of clay-soils, except that of a white colour, have these two advantages above the finest gravel soils, that they do not scorch soon by dry weather, and never grow weary of the same manure, as most other soils do.

The extraordinary hand-labour bestowed in making dung, may be saved by the art of caving, now in general use in England. Ten mules or horses, and two light tumbrels with broad wheels, and ten able negroes, may, by the common use of spades, shovels, and light mattocks, or grubbing hoes, make more dung than 60 able negroes can do in the present methods.

If marle lies upon rising ground, or in hillocks, as it often does, the pit is to be opened at the foot of the declivity; which being dug inwards, till the bank is three feet high, then it is to be *caved* thus. Dig an hollow space of 12 or 18 inches deep under the foot of the bank; then dig into each side of it another perpendicular cut of the same depth, and 18 inches wide from the top of the bank to the bottom: that being finished, make a small trench a foot or two from the brink of the bank; pour into it water till full; and when that is done, fill it again, till the water soaking downward makes the marle separate and fall down all at once. This may be repeated till the pit rises to 50 feet high; and then many hundreds of cart-loads of marle may be thrown down by four negroes in two hours; from whence it may be carted into cattle-pens or laid out upon lands, as occasion requires. Five or six negroes with spades or shovels will keep two or three tumbrels employed, according to the distance of cartage: and thus as much dung may be made by ten negro men as will dung richly at least 70 or 80 acres of land every year, and laid out also with the assistance of cattle-carts: An improvement highly worth every planter's consideration, when negroes and feeding them are so expensive; and this is no speculation, but has been confirmed by practice. In level lands, the same operation may be as effectual, provided the mouth of the pit be opened by gradual descent to any depth: but when marle is to be found on the sides of hills, the operation is less laborious for the horses. But if the surface of the marle-pits (as it often happens) be covered with clay or stiff soil, so that the water cannot quickly soak from the trench above; in that case, pieces of hard wood, made like piles, four feet long, and four inches square, pointed at one end, and secured at the other square head by an iron clamp, may be driven by heavy mauls into the trench, as so many wedges, which will make the caved part tumble down: but a skilful eye must watch the last operation, or the labourers may be buried or hurt.

But then clay-soils that are level, and subject to be drowned, or to retain water in stagnated pools, can never be made fruitful by any kind of manure, without being first well drained: for water lying upon any soil will most certainly transform it to a stiff unfruitful clay; as appears evidently by the bogs of Ireland, the fens of Lincoln and Cambridgeshire, and even by the ponds of Barbadoes situated in the deepest and lightest black mould; for that fine soil being washed into those ponds, becomes the stiffest black clay, not fit even for an ingredient in dung, until it has been laid dry, and exposed to the sun for a whole year: but when these bogs and fens are well drained, they become the most fruitful soils. Natural clay the celebrated Boerhaave thinks the fattest of all soils; but then it must be opened by culture, marle, or sandy manures. It is hard to conjecture how the opinion prevailed in the British plantations, that sandy gut-mould was most unfit for clay-soils, as being the means of binding them to the compactness of brick; whereas it is proved, from long experience, to be one of the best means of opening clay-soils, and rendering them abundantly fruitful. Brick is made of *clay alone;* no sand being used in it, farther than to sprinkle the board, on which it is moulded into shape. From repeated experience it appears, that a mixture of sand in gut-mould is the best of all manure for stiff and barren clay-lands; provided they be well drained, by throwing the whole soil into round ridges of 12 feet wide, with furrows of three feet wide between each ridge. And this is done with little more hand-labour than that of hoe-ploughing well in the common way. For if a piece of land be marked in lines at seven feet and a half distance from each other, and the labourers are set in to hoe-plough at the second line, hauling back each clod 12 inches; half the ridge, and near half the furrow, is made at the same time: and thus a piece of land may be round-ridged, and the furrows all made at once, by the common operation of hoe-ploughing, provided the digger drives his hoe up to the eye at every stroke. Hoe-ploughing

---

been much injured in some of the islands by dung hastily made with marle: but if the sediment of lees were thrown into these pens, after being turned over, it would much improve the dung.

Planter-ship.

ploughing in clay-soils that have lain long under water, is indeed hard labour; but it will every year grow the lighter by being well-drained by round-ridging: and in the meanwhile the labour may be rendered much more easy by the plough conducted by the lines above described. As therefore sandy mould is the best manure for stiff clay; so, by parity of reason, confirmed by long experience, stiff clay is the best manure for sandy or chaffy soils.

The method of round-ridging before described, is, by several years experience, found the most essential improvement of flat clayey soils: and yet there are some who will prefer speculation to ocular demonstration, fancying that all kinds of ridges will carry off the mould in heavy rains. The fact is otherwise in clay-soils: and plain reason, without experience, vouches, that where great confluxes of water are divided into many small rills, the force is broken; and therefore less mould carried off the land. Another objection made to round-ridgeing is, that by digging much clay to form the sides of the ridge, the soil is impoverished: but this objection stands good only against those ridges which are raised too high, and made too broad; but if land is ridged in the manner before directed, that is, 12 feet broad, and not above six or eight inches higher in the middle than at the sides, the objection vanishes. Ridges were never proposed for light soils or steep lands; and even in flat soils upon loam they should be made with great caution, because *loam melts away by water.* But there are poachy lands of a white clay, even upon small descents, too retentive of water; these may certainly be improved much by ridges of 12 feet wide, as above described, without fear of washes.

But supposing, as the objection urges, that a little clay should be turned up at the sides of such ridges, can it not be manured somewhat more than the other parts with marle or sandy mould, so as to become equally good with any other part of the soil? And is not this well worth the labour, since round-ridging not only improves the soil by draining it to a surprising degree, but adds one-fifth part to the depth of the staple? And will not a ridge made a little rounding, throw off the water much better than a flat ridge?

The general maxim of not burning cane-trash (which may be called the *stubble of cane-lands)* upon any kind of soil, is surely a great mistake; as may be evinced by observing the contrary practice of the best husbandmen in England, where burn-baiting or bastard burn-baiting, is found by experience an admirable method of fertilizing cold, stiff, or clayey lands. It must indeed be a constant practice, not only for the sake of contributing to warm and divide the soil, but as the only effectual means of destroying pernicious insects, and weeds of various kinds, such as French weed, wild pease, and wild vines.

Soon after the disuse of burning trash upon our lands in the islands, the blast made its first appearance with incredible devastation: to revive that practice therefore seems to be the most obvious means of expelling it. It may be presumed that the disuse of burning trash was founded upon the mistaken notion of burn-baiting, which is turning up a thick sod of very dry, light, and shallow soils, and burning the whole superficies or staple to ashes. This practice the writers upon husbandry condemn universally, and very justly: for though by this practice the land will produce two or three crops more plentifully than ever, yet the soil is blown away by the wind, and the substratum being generally an hungry gravel or chalk, can never be restored to fertility by the common arts of husbandry. But surely this has no resemblance to our superficial burning of the little trash we can spare from dung: and though this method of burn-baiting light and shallow soils be justly condemned, yet the best writers recommend that very practice in cold, moist, and heavy soils, as is observed above; and long experience justifies it.

Deep mould upon clay or loam being subject to the grub-worm (c), will not take any kind of dung, till perfectly rotten, except that of the sheep-fold; which is the best manure for all kinds of light soils, and is of all others the least expensive, as not requiring hand-labour. But the use of the fold is impracticable in any island not abounding with large savannas or sheep-pastures, as in Jamaica.

Those soils therefore which are subject to the grub, and must be fertilized by common dung, which is a proper nest for the mother-beetle to deposite its eggs, must be well impregnated with the brine of dissolved salt, after the dung is first cut up; two large hogsheads of salt will make brine enough for a dung-pen of 50 feet square.

This cure for the grub is a late discovery; and which has been attended with success, so far as the experiment is made. But though it proves effectual to destroy that pernicious insect in plant-canes, it probably will not be sufficient to save rattoons, without a new application of salt in powder; because the first brine must be washed away by the time when rattoons spring up.

The planter who would save his rattoons from the grub ought therefore to cut off the heads of his stools with sharp hoes three inches below the surface of the soil, and then strew an handful of salt round each stool, and cover it up to a level with fine mould taken from the edges.

In soils where there is no grub, and the planter wishes to have very good rattoons, let him, as soon as his canes are cut, draw all the trash from the stools into the alternate spaces, if planted in that manner; or into the furrows, if his land be round-ridged; and then cut off the head of his stools with sharp hoes, as above directed. Experience has shown the advantage of this practice, and reason demonstrates the great benefit of the rattoon-sprouts rising from three inches below the surface, instead of superficial shoots which come to nothing, and only starve the strong sprouts. Besides, the stubs which are left upon the stools after the canes are cut, canker, and rot the stools; which is one reason why good rattoons

(c) This pernicious insect is most apt to engender in dung made from mill-trash, which therefore never ought to be put into dung-compost or still-ponds; but after being burnt, the ashes will be as good as any other kind. Round-ridging, with manure of unwet ashes, sea-sand, or lime, or dry marle, kills the grub.

Plantership.

toons are uncommon in ſoils long cultivated. Yet it is the opinion of ſome, that by hoe-ploughing and even dunging rattoons, the produce might be as good plant-canes, which would ſave the labour of holing and planting ſo often as planters commonly do.

Fallowing is of incredible advantage to every ſoil, not only by being divided into the minuteſt parts, but alſo by imbibing thoſe vegetative powers with which the air is impregnated by the bountiful hand of Providence, whenever rain falls. What thoſe powers are has been explained under the articles AGRICULTURE and PLANT; and experience evinces, that the tender vegetables of the earth are envigorated more by the ſmalleſt ſhower of rain, than by all the water which human art can beſtow. Let it therefore be a conſtant maxim of the planter, never to plant his ground until the ſoil is well mellowed by fallowing, even though he beſtows upon it a due proportion of dung: we ſay a due proportion; for too much will force up rank canes, which never yield good ſugar; and though ſome advantage may be reaped from the rattoons, yet it will be found by experience not to compenſate the loſs by the plants. In ſtony or ſteep ſoils, where the plough cannot be uſed, or where a ſufficient ſtrength of cattle cannot be ſupported for that purpoſe, hand-labour or hoe-ploughing muſt be ſubſtituted: but even in that caſe, much labour may be ſaved by ſpreading the dung according to the Engliſh huſbandry, and digging it into the ſoil. To evince this truth, let any planter compute his negroes labour of diſtributing dung by baſkets, and by ſpreading it with dung-forks; and then judge for himſelf by one ſingle experiment which is the moſt profitable.

But if ſome planters are ſo devoted to the old cuſtom of diſtributing dung by baſkets inſtead of wheel-barrows in level ground, or hand-barrows in uneven land, by which three times the labour may be accompliſhed in the ſame time and by the ſame hands; let them at leaſt ſave much of their hand-labour, by the following method of laying out dung, before the diſtribution by baſkets.

In holing a piece of land, let a ſpace be left after 80 holes from the firſt interval, and then the like ſpace after 80 holes throughout the whole plat, which ſpaces muſt run exactly parallel to the intervals on the right and left of the holes. Into theſe ſpaces the dung may be carted, even before it be rotten (D), at the moſt leiſure times, and covered with mould or cane-traſh, to prevent exhalation; and in ſuch quantity as will ſuffice only to dung a row of 40 holes, from the point oppoſite to each ſide of it. In the intervals at each ſide of the cane-piece, which are parallel to thoſe ſpaces, there muſt be dung enough carted to manure a row of 40 holes, and covered in like manner.

By thus placing the dung or gut-mould, it is evident at the firſt ſight, that the fartheſt diſtance cannot be above 40 holes in diſtributing the dung: and in caſe it be not ſufficiently rotten for preſent uſe, it may be diſtributed even in dry weather, and covered by the bank; which will both prevent its ſpirit from exhalation, and occaſion it to rot ſooner, which is no ſmall advantage. Moreover, by being thus laid out at the moſt leiſure times, and covered with the banks, the dung will be more intimately mixed with the ſoil, and therefore continue to nouriſh the plant for a longer time than if laid as uſual at the bottom of the holes. A farther advantage of thus diſtributing the dung, and covering it, reſults from the more expeditious planting the land after a ſhort or ſudden ſhower: for the labour of covering the dung, and uncovering it when the land is planted, however it may appear in ſpeculation, is in practice a trifle; and beſides all the other advantages ariſing by the diſtribution of dung from the ſpaces above deſcribed, this is not the leaſt, that not a bank is trodden under foot. But it is evident, that by diſtributing the dung with baſkets in the preſent method, the ſoil is much trampled under foot; and by that means, the very end of hoe-ploughing, or looſening the ſoil, is much defeated. In like manner, by the preſent method of hoe-ploughing, the ſame ill effect is produced; for as the negroes hoe-plough or dig the ſoil directly forward, ſo they muſt neceſſarily tread the ground as faſt as they dig it: whereas by putting the labourers to dig ſidewiſe, no one puts a foot upon the ſoil after it is dug; and by lining the land before it is hoe-ploughed, each negro may have an equal ſhare to dig. The only difficulty of hoe-ploughing ſidewiſe is in firſt ſetting the negroes to that work; but it may be done without loſs of time when working in a contiguous field. Whether hoe-ploughing before or after the land be holed for canes is moſt eligible, experience muſt determine; but certainly both operations will be moſt effectual: and therefore it will be adviſable (E), firſt to plough the ſoil where the land will admit the plough; and where it will not, to hoe-plough it, with or without dung, as requiſite; then let it lie fallow till perfectly mellowed; then hole and plant it; and inſtead of weeding in the uſual manner, let the weeds in all the ſpaces be dug into the ſoil: but as this is not to be done ſo well with the hoe, it is ſubmitted to future experience, whether the dexterous uſe of ſpades, as in England, will not anſwer the purpoſe much better, and with equal diſpatch. But whatever method is preferred, moſt certain it is, that by looſening the ſoil in all the ſpaces between the young canes after being come up, their fibres will more eaſily expand on every ſide, and acquire more nutrition to invigorate their growth. But where the planter grudges this labour, by thinking it needleſs in a rich looſe ſoil, he may diſpatch more weeding-work by the Dutch hoe than by any other; which being faſtened upon

(D) In order to make dung rot the ſooner, much labour is beſtowed in digging and turning it over by hoes: but two-thirds of that labour may be ſaved by the uſe of hay-knives; ſix of which, uſed dexterouſly, will cut up a pen in leſs time than 60 negroes can do by hoes: but hay-knives cannot be uſed where gritty mould is uſed in pens.

(E) Deep and looſe ſoils may be ploughed with a ſmall ſtrength of cattle or mules: but ſtiff lands in hot climates require more ſtrength of cattle than can be maintained in the ſmall paſtures of the planters; for if thoſe ſtrong ſoils are either too wet or too dry (as is generally the caſe), ploughing is impracticable.

Planter-ſhip.

upon the end of a ſtick, is puſhed forward under the roots of the ſmall weeds, in ſuch a manner as to cut them up a little below the ſurface of the ſoil, and will do more execution at one ſhove than can be done at three ſtrokes of the common hoe: but there is yet another practice of the horſe-hoe plough, whereby all weeds growing in rows between beans and peaſe, are extirpated with incredible eaſe and expedition. It is a very ſimple machine, drawn by one or two horſes, conſiſting of a pair of low wheels turning upon a common axis; from whence two ſquare irons are let down at equal diſtances, and triangular hoes made at the ends, the points of the triangles being placed forward, and ſo fixed as to cut all weeds an inch below the ſurface, in the ſame manner as the Dutch garden hoe above-mentioned. By this machine a man and a boy, with two horſes or mules, will clear perfectly all the ſpaces of a field of ten acres in two days, and may be of admirable uſe in all looſe and dry ſoils in the ſugar-iſlands: for while two horſes or mules draw in the ſpace before each other, the wheels paſs on the outſide of each row of canes, without doing the leaſt injury, while the plough-holder attends to his buſineſs. In ſtiff ſoils which require draining, neither the horſe-hoe plough nor the Dutch hoe can be proper; or any other inſtrument ſo effectual as the ſpade uſed in the manner above hinted, where the ſtaple is deep.

But where the ſtaple of land is ſhallow, care muſt be taken not to dig much below it, according to the univerſal opinion of all the beſt writers, ſupported by the experience of 100 years. Yet ſome good planters are fallen into the contrary practice, and dig up ſtiff clay far below the ſtaple. This, Mr Martin ſays, was done in his own lands, during his abſence, by injudiciouſly ploughing below the ſtaple; and ſo injured the ſoil, that all the arts of culture for many years hardly retrieved its former fertility. Indeed, where the ſtaple is ſhallow, upon a fat clay, the turning up a little of it at a time, from the bottom of the cane-holes, and mixing it with rich hot dung, made of marle, or ſandy mould, which may take off its coheſive quality, will in due time, and by long fallow, convert it into good ſoil: but if ſtiff clay be turned up, without any ſuch mixture, in large quantities, it will infallibly diſappoint the operator's hopes: for though ſolid clay will moulder, by expoſure, to a ſeeming fine earth, yet it will return to its primitive ſtate very ſoon after being wet, and covered from the external air, if not divided, as above ſuggeſted.

After all, the common horſe-hoeing plough drawn by two mules in a line before each other, or the hand-hoe in common uſe, will anſwer the purpoſe very well, where the lands are planted in Mr Tull's method; that is, where the ſpaces are equal to the land planted, in the following manner.

Suppoſe ſix feet planted in two rows of canes, and ſix feet of land left as a ſpace unplanted; and ſo a whole piece of land, planted in alternate double rows (F), with equal ſpaces, may be hoe-ploughed with eaſe, as before hinted; and that at any time during the growth of canes, when it is moſt convenient to the planter, which is a conſiderable advantage; and yet it is the leaſt of all attending this method of culture: for, by leaving theſe ſpaces, the canes will have both more air and ſun: by hoe-ploughing them, the roots of each double row will have large room for expanſion, and conſequently, by gaining more nutriment, will grow more luxuriantly: by theſe ſpaces the canes may be cleaned from the blaſt with much more eaſe and convenience; and will ſerve as proper beds to plant great corn, without the leaſt injury to the canes; as well as to contain the traſh taken off the land, where, by rotting, and being hoe-ploughed into the ſoil, it will wonderfully enrich it, and will fit it to be planted immediately after the canes in the neighbouring double rows are cut down. Beſides all theſe admirable advantages of planting the land in alternate double rows with equal ſpaces, the canes, when at full age, may be eaſily ſtripped of their traſh, and by that means the juice rendered ſo mature as to yield double the produce, and much better ſugars than unſtripped canes. This method of culture may be recommended for all kinds of ſoil: for as by this practice the rank luxuriant canes will be more matured, ſo the poor ſoils will be rendered more fruitful; and as the roots of the canes which expand into theſe ſpaces will be kept moiſt by being covered with rotten traſh, ſo they muſt bear dry weather much longer in the burning ſoils. In thoſe low lands which require draining by furrows, the alternate double rows and ſpaces muſt be made croſs the ridges; by which means thoſe ſpaces, being hoe-ploughed from the centre to the ſides, will be always preſerved in a proper ſtate of roundneſs. By this method of planting, the canes may be ſo well ripened as to yield double the quantity of ſugar of canes planted in the cloſe manner; which ſaves half the labour of cartage, half the time of grinding and boiling, and half the fuel, beſides yielding finer ſugar.

Yet, how well ſoever the method of planting in ſingle or double alternate rows has ſucceeded in the looſe and ſtiff ſoils, experience has ſhown that it is a wrong practice in ſtiff lands that are thrown into round or flat ridges: for theſe being moſt apt to crack, the ſun-beams penetrate ſoon to the cane-roots, ſtop their growth, and have an ill influence upon the ſugar. It is therefore adviſable to plant ſuch lands full, but in large holes, of 4 feet, by 5 feet towards the banks: after the plant-canes are cut, to dig out one, and leave two rows ſtanding, hoe-ploughing the ſpaces after turning all the traſh into furrows till almoſt rotten: for if the traſh is drawn upon the hoe-ploughed ſpaces, they will hardly ever moulder, at leaſt not till the traſh is quite rotten. This is an infallible proof from experience of how little advantage traſh is to the ſoil, unleſs it be in great droughts, to keep out the intenſe ſun-beams: for, in all other reſpects, it prevents that joint operation of the ſun and air in mouldering and fructifying the ſoil, as has been proved by repeated experiments.

But in flat ſtiff ſoils that are properly drained by round-ridging, no culture prevents cracking ſo effectually as hoe-ploughing into them a quantity of looſe marle, of which that of a chocolate or of a yellow colour is beſt;

(F) In ſtiff lands, the ſingle alternate rows of four feet diſtance, as preventive of much labour in weeding, are found beſt; and alſo yield more ſugar by the acre; and are leſs apt to be affected by drought.

Plantership.

beſt; and it will be ſtill much better, by lying upon the land, in ſmall heaps, or in cane-holes, for ſome time, to imbibe the vegetative powers of the air before it is intimately mixed with the ſoil.

As to the manner of planting canes, the general practice of allowing four feet by five to an hole, and two freſh (G) plants, is found by common experience to be right and good in alternate rows. But the following precautions are neceſſary to be obſerved. Firſt, let all the cane-rows run eaſt and weſt, that the trade-wind may paſs freely through them; becauſe air and ſunſhine are as conducive to the growth and maturation of ſugar-canes as of any other vegetable. Secondly, let not any acceſſion of mould be drawn into hills round the young canes, except where water ſtagnates (H); becauſe the fibres which run horizontally, and near the ſurface, are much broken and ſpoiled by that practice. Thirdly, let the ſugar-canes be cut at their full maturity; which, in a dry looſe ſoil, is generally at the end of 14 or 15 months after being planted; but in cold clay-ſoils, not till 16 or 17 months. Fourthly, as the cane-rows run eaſt and weſt in as proper a direction as poſſible for cartage to the ſugar work, ſo canes muſt be cut the contrary way if the planter expects any great produce from his rattoons: for by beginning to cut canes at the part of his field moſt remote from the works, the carts cannot often paſs over the ſame tract, and conſequently the cane-ſtools cannot be injured, more eſpecially if he takes due care to cut the canes very cloſe to their roots; for, by leaving a long ſtub (which muſt periſh) the cane-ſtools are much injured. It may be objected to the practice of the cutting canes tranſverſely to the rows, that the negroes labour will not be ſo equally divided: but let every man conſider both ſides of the queſtion, and be determined by his own experience; and then he will be convinced, that it matters very little which way he cuts ſtraight ſtanding canes; but in caſes where the ſugar-canes lean, or are lodged by preceding high winds, it is a point of great importance to place the labourers ſo as to cut the canes firſt at the roots, and then, drawing them, cut off the tops: for thus by two ſtrokes each cane will be cut; and twice the quantity cut in the ſame time, and by the ſame hands, more than by cutting in any other direction. In round-ridged land, it is proper to cut canes in the ſame direction of the ridges, throwing the tops and traſh into the furrows to render the cartage eaſy, and to preſerve the ridges in their proper form.

It is almoſt needleſs to ſuggeſt the expediency of planning the cane-pieces of a plantation in exact ſquares, ſo that the intervals may interſect at right angles; ſince ſuch regularity is not only more beautiful, more ſafe in caſe of accidental fires, and a better diſpoſition of the whole for dividing and planting one third or fourth part of a plantation every year, but alſo much eaſier guarded by a few watchmen: for one of theſe walking in a line from eaſt to weſt, and the other from north to ſouth, look through every avenue, where the moſt ſubtle thief cannot eſcape the watchful eye. And if the intervals ſurrounding the boundary of a regular plantation be made 24 feet wide, the proprietor will receive ample recompenſe for ſo much land, by the ſecurity of his canes from fires kindled in the neighbourhood, and by planting all that land in plantain-trees, which may at once yield food and ſhade to the watchmen, who by that means can have no excuſe for abſence from their proper ſtations. But as fuel grows very ſcarce in moſt of our iſlands, it is alſo expedient to plant a logwood or flower-fence in all the boundaries of every plantation, which, being cut every year, will furniſh good ſtore of faggots. Logwood makes the ſtrongeſt and quickeſt of all fences, and agrees with every ſoil: the cuttings make excellent oven-fuel.

So much for the general operations of planterſhip, according to the approved directions of Mr Martin. For the particular cultivation of the ſugar-canes, the extraction of the ſugar, and the diſtillation of rum, ſee the articles SACCHARUM, SUGAR, and RUM.

PLANTIN (Chriſtopher), a celebrated printer, was born near Tours in 1533, and bred to an art which he carried to the higheſt degree of perfection. He went and ſettled at Antwerp; and there erected a printing-office, which was conſidered not only as the chief ornament of the town, but as one of the moſt extraordinary edifices in Europe. A great number of ancient authors were printed here; and theſe editions were valued not only for the beauty of the characters, but alſo for the correctneſs of the text, with regard to which Plantin was ſo very nice, that he procured the moſt learned men to be correctors of his preſs. He got immenſe riches by his profeſſion; which, however, he did not hoard up, but ſpent like a gentleman. He died in 1598, aged 65 years; and left a moſt ſumptuous and valuable library to his grandſon Balthaſar.

Planting.

PLANTING, in agriculture and gardening, is ſetting a tree or plant, taken from its proper place, in a new hole or pit; throwing freſh earth over its root, and filling up the hole to the level of the ſurface of the ground.

The firſt thing in planting is to prepare the ground before the trees or plants are taken out of the earth, that they may remain out of the ground as ſhort a time as poſſible; and the next is, to take up the trees or plants, in order to their being tranſplanted. In taking up the trees, carefully dig away the earth round the roots, ſo as to come at their ſeveral parts to cut them off; for if they are torn out of the ground without care, the roots will be broken and bruiſed, to the great injury of the trees. When you have taken them up, the next thing is to prepare them for planting by pruning the roots and heads. And firſt, as to the roots; all the ſmall fibres are to be cut off, as near to the place from whence they

(G) It is an odd fancy that ſtale plants grow beſt, when both reaſon and experience vouch that the moſt ſucculent plants are beſt: one good plant in the centre of a large hole is ſufficient when the land is full holed.

(H) The ſtagnation of water in pools (uſual in ſtiff level lands) is the moſt injurious circumſtance attending it; for that, by long duration, will convert the fineſt mould into ſtiff clay. The proprietor of ſuch a ſoil muſt therefore grudge no labour to drain it well; and yet by ſuch eaſy gradation as to prevent the mould from being waſhed away by great floods, in caſe the under ſtratum be a loam.

Planting. they are produced as may be, except they are to be replanted immediately after they are taken up. Then prune off all the bruiſed or broken roots, all ſuch as are irregular and croſs each other, and all downright roots, eſpecially in fruit-trees: ſhorten the larger roots in proportion to the age, the ſtrength, and nature of the tree; obſerving that the walnut, mulberry, and ſome other tender-rooted kinds ſhould not be pruned ſo cloſe as the more hardy ſorts of fruit and foreſt trees: in young fruit-trees, ſuch as pears, apples, plums, peaches, &c. that are one year old from the time of their budding or grafting, the roots may be left only about eight or nine inches long; but in older trees, they muſt be left of a much greater length: but this is only to be underſtood of the larger roots; for the ſmall ones muſt be chiefly cut quite out, or pruned very ſhort. The next thing is the pruning of their heads, which muſt be differently performed in different trees; and the deſign of the trees muſt alſo be conſidered. Thus, if they are deſigned for walls or eſpaliers, it is beſt to plant them with the greateſt part of their heads, which ſhould remain on till they begin to ſhoot in the ſpring, when they muſt be cut down to five or ſix eyes, at the ſame time taking care not to diſturb the roots. But if the trees are deſigned for ſtandards, you ſhould prune off all the ſmall branches cloſe to the place where they are produced, as alſo the irregular ones which croſs each other; and after having diſplaced theſe branches, you ſhould alſo cut off all ſuch parts of branches as have by any accident been broken or wounded; but by no means cut off the main leading ſhoots which are neceſſary to attract the ſap from the root, and thereby promote the growth of the tree. Having thus prepared the trees for planting, you muſt now proceed to place them in the earth: but firſt, if the trees have been long out of the ground, ſo that the fibres of the roots are dried, place them eight or ten hours in water, before they are planted, with their heads erect, and the roots only immerſed therein; which will ſwell the dried veſſels of the roots, and prepare them to imbibe nouriſhment from the earth. In planting them, great regard ſhould be had to the nature of the ſoil: for if that be cold and moiſt, the trees ſhould be planted very ſhallow; and if it be a hard rock or gravel, it will be better to raiſe a hill of earth where each tree is to be planted, than to dig into the rock or gravel, and fill it up with earth, as is too often practiſed, by which means the trees are planted as it were in a tub, and have but little room to extend their roots. The next thing to be obſerved is, to place the trees in the hole in ſuch a manner that the roots may be about the ſame depth in the ground as before they were taken up; then break the earth fine with a ſpade, and ſcatter it into the hole, ſo that it may fall in between every root, that there may be no hollowneſs in the earth; then having filled up the hole, gently tread down the earth with your feet, but do not make it too hard; which is a great fault, eſpecially if the ground be ſtrong or wet. Having thus planted the trees, they ſhould be faſtened to ſtakes driven into the ground to prevent their being diſplaced by the wind, and ſome mulch laid upon the ſurface of the ground about their roots; as to ſuch as are planted againſt walls, their roots ſhould be placed about five or ſix inches from the wall, to which their heads ſhould be nailed to prevent their being blown up by the wind. The ſeaſons for planting are various, according to the different ſorts of trees, or the ſoil in which they are planted. For the trees whoſe leaves fall off in winter, the beſt time is the beginning of October, provided the ſoil be dry; but if it be a very wet ſoil, it is better to defer it till the latter end of February, or the beginning of March: and for many kinds of evergreens, the beginning of April is by far the beſt ſeaſon; though they may be ſafely removed at midſummer, provided they are not to be carried very far; but ſhould always make choice of a cloudy wet ſeaſon. Planting.

In the ſecond volume of the papers, &c. of the Bath Society there is a letter on planting waſte grounds. The gentleman who writes it informs us, that in the county of Norfolk, where he reſides, there were about 60 or 70 years ago vaſt tracts of uncultivated ground, which were then thought totally barren. "The weſtern parts of it (ſays he) abounded with ſand of ſo light a texture, that they were carried about by every wind; and in many places the ſands were ſo looſe that no graſs could grow upon them. Art and induſtry, however, have now ſo altered the face of this once Arabian deſert, that it wears a very different appearance. Moſt of theſe tracts are either planted or rendered very good corn-land and ſheep-walks.

"About 30 years ſince, the ſides of many of our little ſand-hills were ſown with the ſeeds of French furze, and when a wet ſeaſon followed, they ſucceeded very well, and grew ſo faſt, that once in three or four years they are cut for fuel, and ſell at a good price at Thetford, Brandon, Harling, Swaffham, and places adjacent. This excited ſome public ſpirited gentlemen, among whom was the late Mr Buxton of Shadwell-Lodge, near Thetford, to attempt the planting of Scotch and ſpruce firs, and other hardy foreſt-trees. At firſt they found ſome difficulty from the extreme looſeneſs of the ſand. But as there is in all this part of the country fine white and yellow marle, at about three feet depth below the ſand, they very judiciouſly thought that incorporating it with the ſand in the holes where their young trees were planted, would inſure ſucceſs; nor were they diſappointed. The method ſucceeded beyond expectation; the plantations throve exceedingly, and the roots ſoon reached below the ſand, after which they were out of danger. This excited them to further attempts.

"On the ſpots where they intended to raiſe new plantations from ſeeds and acorns, they laid on a thick coat of marle and clay, which after being rough ſpread, and lying a winter in that ſtate, was made fine, and ploughed in juſt before planting. By theſe means the ſoil became fixed, and in a little time covered with graſs and herbage; ſo that there are now vaſt plantations of firs, oak, and foreſt-trees, in the moſt healthy and vigorous ſtate, where within my memory ten acres of land would not maintain a ſingle ſheep three months.

"But the benefit of plantations, whether of ſhrubs, copſe, or trees, is not confined to the immediate advantage, or even the future value of the wood. By annually ſhedding a great number of leaves, which the winds diſperſe, and the rains waſh into the ſoil, it is conſiderably improved; and whenever ſuch copſes have been ſtubbed up, the ground (however unfruitful before planting) has thereby been ſo enriched as to bear excellent crops for many years, without the additional help of manure. How much land-owners are intereſted in planting waſte or barren ſpots I need not mention; and nothing

thing but a degree of indolence or ignorance unpardonable in this enlightened age could induce them to neglect it.

"Nature has furnished us with plants, trees, and shrubs, adapted to almost every soil and situation; and as the laws of vegetation are now much better understood than formerly, it is a reproach to those whose practice does not keep pace with their knowledge in making the best use of her bounty. Let no man repine and say *the land is barren;* for those spots which appear to be so, owe that appearance to human negligence. Industry and art might soon render an eighth part of this kingdom nearly as valuable as the rest, which now remains in a state unprofitable to the owners, and disgraceful to the community."

Reverse PLANTING, a method of planting in which the natural position of the plant or shoot is inverted; the branches being set into the earth, and the root reared into the air. Dr Agricola mentions this monstrous method of planting, which he found to succeed very well in most or all sorts of fruit-trees, timber-trees, &c. Bradley affirms, that he has seen a lime-tree in Holland growing with its first roots in the air, which had shot out branches in great plenty, at the same time that its first branches produced roots and fed the tree. Mr Fairchild of Hoxton has practised the same with us, and gives the following directions for performing it: Make choice of a young tree of one shoot, of alder, elm, willow, or any other tree that easily takes root by laying; bend the shoot gently down into the earth, and so let it remain until it has taken root. Then dig about the first root, and raise it gently out of the ground, till the stem be nearly upright, and stake it up. Then prune the roots, now erected in the air, from the bruises and wounds they received in being dug up; and anoint the pruned parts with a composition of two ounces of turpentine, four ounces of tallow, and four ounces of bees wax, melted together, and applied pretty warm. Afterwards prune off all the buds or shoots that are upon the stem, and dress the wounds with the same composition, to prevent any collateral shootings, that might spoil the beauty of the stem.

PLANUDES (Maximus), a Greek monk of Constantinople, towards the end of the 14th century, who published a collection of epigrams intitled *Anthologia;* a Greek translation of Ovid's Metamorphoses; a Life of Æsop, which is rather a romance than a history; and some other works. We know nothing more of him, than that he suffered some persecution on account of his attachment to the Latin church.

PLASHING *of* HEDGES, is an operation thought by some persons to promote the growth and continuance of old hedges; but whether the fact be so or not will admit of some dispute. See HEDGES, n° 29, 37, &c.

It is performed in this manner: The old stubs must be cut off, &c. within two or three inches of the ground; and the best and longest of the middle-sized shoots must be left to lay down. Some of the strongest of these must also be left to answer the purpose of stakes. These are to be cut off to the height at which the hedge is intended to be left; and they are to stand at ten feet distance one from another: when there are not proper shoots for these at the due distances, their places must be supplied with common stakes of dead wood. The hedge is to be first thinned, by cutting away all but those shoots which are intended to be used either as stakes, or the other work of the plashing: the ditch is to be cleaned out with the spade; and it must be now dug as at first, with sloping sides each way; and when there is any cavity on the bank on which the hedge grows, or the earth has been washed away from the roots of the shrubs, it is to be made good by facing it, as they express it, with the mould dug from the upper part of the ditch: all the rest of the earth dug out of the ditch is to be laid upon the top of the bank: and the owner should look carefully into it that this be done; for the workmen, to spare themselves trouble, are apt to throw as much as they can upon the face of the bank; which being by this means overloaded, is soon washed off into the ditch again, and a very great part of the work undone; whereas what is laid on the top of the bank always remains there, and makes a good fence of an indifferent hedge.

In the plashing the quick, two extremes are to be avoided; these are, the laying it too low, and the laying it too thick. The latter makes the sap run all into the shoots, and leaves the plashes without sufficient nourishment; which, with the thickness of the hedge, finally kills them. The other extreme of laying them too high, is equally to be avoided; for this carries up all the nourishment into the plashes, and so makes the shoots small and weak at the bottom, and consequently the hedge thin. This is a common error in the north of England. The best hedges made anywhere in England are those in Hertfordshire; for they are plashed in a middle way between the two extremes, and the cattle are by that prevented both from cropping the young shoots, and from going through; and a new and vigorous hedge soon forms itself.

When the shoot is bent down that is intended to be plashed, it must be cut half way through with the bill; the cut must be given sloping, somewhat downwards, and then it is to be wound about the stakes, and after this its superfluous branches are to be cut off as they stand out at the sides of the hedge. If for the first year or two, the field where a new hedge is made can be ploughed, it will thrive the better for it; but if the stubs are very old, it is best to cut them quite down, and to secure them with good dead hedges on both sides, till the shoots are grown up from them strong enough to plash; and wherever void spaces are seen, new sets are to be planted to fill them up. A new hedge raised from sets in the common way, generally requires plashing in about eight or nine years after.

PLASSEY, is a grove near the city of Muxadab in India, famous for a battle fought between the English under Lord Clive and the native Hindoos under the Nabob Surajah Dowlah. The British army consisted of about 3200 men, of whom the Europeans did not exceed 900; while that of the Nabob consisted of 50,000 foot, and 18,000 horse. Notwithstanding this great disproportion, however, Lord Clive effectually routed the Nabob and his forces, with the loss of 3 Europeans and 26 Seapoys killed, and 5 Europeans and 40 Seapoys wounded. The Nabob's loss was estimated at about 200 men, besides oxen and elephants. See CLIVE.

PLASTER, or EMPLASTER, in pharmacy, an external application of a harder consistence than an ointment;

Plaster. ment; to be spread, according to the different circumstances of the wound, place, or patient, either upon linen or leather. See PHARMACY, n° 613—635.

PLASTER, or *Plaister*, in building, a composition of lime, sometimes with sand, &c. to parget, or cover the nudities of a building. See PARGETING and STUCCO.

PLASTER of Paris, a preparation of several species of gypsum dug near Mount Maitre, a village in the neighbourhood of Paris; whence the name. See ALABASTER, GYPSUM, and CHEMISTRY, n° 635, &c.

The best sort is hard, white, shining, and marbly; known by the name of *plaster-stone* or *parget of Mount Maitre*. It will neither give fire with steel, nor ferment with aquafortis; but very freely and readily calcines in the fire into a fine plaster, the use of which in building and casting statues is well known.

The method of representing a face truly in plaster of Paris is this: The person whose figure is designed is laid on his back, with any convenient thing to keep off the hair. Into each nostril is conveyed a conical piece of stiff paper, open at both ends, to allow of respiration. These tubes being anointed with oil, are supported by the hand of an assistant; then the face is lightly oiled over, and the eyes being kept shut, alabaster fresh calcined, and tempered to a thinnish consistence with water, is by spoonfuls nimbly thrown all over the face, till it lies near the thickness of an inch. This matter grows sensibly hot, and in about a quarter of an hour hardens into a kind of stony concretion; which being gently taken off, represents, on its concave surface, the minutest part of the original face. In this a head of good clay may be moulded, and therein the eyes are to be opened, and other necessary amendments made. This second face being anointed with oil, a second mould of calcined alabaster is made, consisting of two parts joined lengthwise along the ridge of the nose; and herein may be cast, with the same matter, a face extremely like the original.

If finely powdered alabaster, or plaster of Paris, be put into a bason over a fire, it will, when hot, assume the appearance of a fluid, by rolling in waves, yielding to the touch, steaming, &c. all which properties it again loses on the departure of the heat; and being thrown upon paper, will not at all wet it, but immediately discover itself to be as motionless as before it was set over the fire; whereby it appears, that a heap of such little bodies, as are neither spherical nor otherwise regularly shaped, nor small enough to be below the discernment of the eye, may, without fusion, be made fluid, barely by a sufficiently strong and various agitation of the particles which compose it; and moreover lose its fluidity immediately upon the cessation thereof.

Two or three spoonfuls of burnt alabaster, mixed up thin with water, in a short time coagulate, at the bottom of a vessel full of water, into a hard lump, notwithstanding the water that surrounded it. Artificers observe, that the coagulating property of burnt alabaster will be very much impaired or lost, if the powder be kept too long, especially if in the open air, before it is made use of; and when it hath been once tempered with water, and suffered to grow hard, they cannot, by any burning or powdering of it again, make it serviceable for their purpose as before.

This matter, when wrought into vessels, &c. is still of so loose and spongy a texture, that the air has easy passage through it. Mr Boyle gives an account, among his experiments with the air-pump, of his preparing a tube of this plaster, closed at one end and open at the other; and on applying the open end to the cement, as is usually done with the receivers, it was found utterly impossible to exhaust all the air out of it; for fresh air from without pressed in as fast as the other, or internal air, was exhausted, though the sides of the tube were of a considerable thickness. A tube of iron was then put on the engine; so that being filled with water, the tube of plaster of Paris was covered with it; and on using the pump, it was immediately seen, that the water passed through into it as easily as the air had done, when that was the ambient fluid. After this, trying it with Venice turpentine instead of water, the thing succeeded very well; and the tube might be perfectly exhausted, and would remain in that state several hours. After this, on pouring some hot oil upon the turpentine, the case was much altered; for the turpentine melting with this, that became a thinner fluid, and in this state capable of passing like water into the pores of the plaster. On taking away the tube after this, it was remarkable that the turpentine, which had pervaded and filled its pores, rendered it transparent, in the manner that water gives transparency to that singular stone called *oculus mundi*. In this manner, the weight of air, under proper management, will be capable of making several sorts of glues penetrate plaster of Paris; and not only this, but baked earth, wood, and all other bodies, porous enough to admit water on this occasion.

Plaster of Paris is used as a manure in Pennsylvania, as we find mentioned in a letter from a gentleman in that country inserted in the 5th volume of the Bath Society Papers, and which we shall insert here for the satisfaction and information of our agricultural readers. "The best kind is imported from hills in the vicinity of Paris: it is brought down the Seine, and exported from Havre de Grace. I am informed there are large beds of it in the Bay of Fundy, some of which I have seen nearly as good as that from France; nevertheless several cargoes brought from thence to Philadelphia have been used without effect. It is probable this was taken from the top of the ground, and by the influence of the sun and atmosphere dispossessed of the qualities necessary for the purposes of vegetation. The lumps composed of flat shining specula are preferred to those which are formed of round particles like sand: the simple method of finding out the quality is to pulverize some, and put it dry into an iron pot over the fire, when that which is good will soon boil, and great quantities of the fixed air escape by ebullition. It is pulverized by first putting it in a stamping-mill. The finer its pulverization the better, as it will thereby be more generally diffused.

"It is best to sow it in a wet day. The most approved quantity for grass is six bushels per acre. No art is required in sowing it more than making the distribution as equal as possible on the sward of grass. It operates altogether as a top manure, and therefore should not be put on in the spring until the principal frosts are over and vegetation hath begun. The general time for sowing with us is in April, May, June, July, August, and even as late as September. Its effects will generally

rally appear in 10 or 15 days; after which the growth of the graſs will be ſo great as to produce a large burden at the end of ſix weeks after ſowing.

"It muſt be ſown on dry land, not ſubject to be overflown. I have ſown it on ſand, loam, and clay, and it is difficult to ſay on which it has beſt anſwered, although the effect is ſooner viſible on ſand. It has been uſed as a manure in this ſtate for upwards of twelve years. Its duration may, from the beſt information I can collect, be eſtimated from ſeven to twelve years; for, like other manure, its continuance very much depends on the nature of the ſoil on which it is placed.

"One of my neighbours ſowed ſome of his graſs ground ſix years ago, another four years ago; a great part of my own farm was ſown in May 1788. We regularly mow two crops, and paſture in autumn; no appearance of failure, the preſent crop being full as good as any preceding. I have this ſeaſon mowed fifty acres of red clover, timothy graſs, white clover, &c. which was plaſtered laſt May, July, and September: many who ſaw the graſs eſtimated the produce at two tons per acre, but I calculate the two crops at three tons. Several ſtripes were left in the different fields without plaſter; theſe were in a meaſure unproductive, being ſcarce worth mowing. In April 1788, I covered a piece of graſs land upwards of two inches thick with barn manure; in the ſame worn-out field I ſowed plaſter, to contraſt it with the dung. I mowed the dunged and plaſtered land twice laſt year and once this; in every crop the plaſter has produced the moſt. You will remember, in all experiments with clover, to mix about one-third timothy graſs ſeed; it is of great advantage in ſerving as a ſupport for the clover; it very much facilitates the curing of clover, and when cured is a ſuperior fodder. The plaſter operates equally as well on the other graſſes as on clover. Its effect is ſaid to be good on wheat, if ſown in the ſpring; but I cannot ſay this from experience. On Indian corn I know its operation to be great; we uſe it at the rate of a table-ſpoonful for a hill, put in immediately after dreſſing.

"From ſome accurate experiments laſt year made and reported to our Agricultural Society, it appears that nine buſhels of additional corn per acre were produced by this method of uſing plaſter."

PLASTERING. See PARGETTING.

PLASTIC, denotes a thing endowed with a formative power, or a faculty of forming or faſhioning a maſs of matter after the likeneſs of a living being.

Plastic-Nature, a certain power by which, as an inſtrument, many philoſophers, both ancient and modern, have ſuppoſed the great motions in the corporeal world, and the various proceſſes of generation and corruption, to be perpetually carried on.

Among the philoſophers of Greece, ſuch a power was almoſt univerſally admitted. It ſeems, indeed, to have been rejected only by the followers of Democritus and Epicurus, who talk as if they had thought gravity eſſential to matter, and the *fortuitous* motion of atoms, which they held to have been from eternity, the ſource not only of all the *regular* motions in the univerſe, but alſo of the *organization* of all corporeal ſyſtems, and even of *ſenſation* and *intellection*, in brutes and in men. It is needleſs to ſay, that thoſe men, whatever they might profeſs, were in reality atheiſts; and Democritus, it is univerſally known, avowed his atheiſm.

The greater part of the philoſophers who held the exiſtence of a plaſtic nature, conſidered it not as an *agent* in the ſtrict ſenſe of the word, but merely as an inſtrument in the hand of the Deity; though even among them there were ſome who held no ſuperior power, and were of courſe as groſs atheiſts as Democritus himſelf Such was *Strato* of Lampſacus. This man was originally of the peripatetic ſchool, over which he preſided many years, with no ſmall degree of reputation for learning and eloquence. He was the firſt and chief aſſertor of what has been termed *Hylozoic atheiſm*; a ſyſtem which admits of no power ſuperior to a certein *natural* or *plaſtic life*, *eſſential*, *ingenerable*, and *incorruptible*, inherent in matter, but without ſenſe and conſciouſneſs. That ſuch was his doctrine we learn from Cicero, who makes *Velleius* the Epicurean ſay, "Nec audiendus *Strato* qui *Phyſicus* appellatur, qui omnem vim divinam in Natura ſitam eſſe cenſet, quæ cauſas gignendi, augendi, minuendive habeat, ſed careat omni ſenſu ‡." That Strato, in admitting this plaſtic principle, differed widely from Democritus, is apparent from the following account of him by the ſame author: "*Strato Lampſacenus* negat opera deorum ſe uti ad fabricandum mundum, quæcunque ſint docet omnia eſſe effecta *naturæ*, nec ut ille, qui aſperis, et levibus, et hamatis uncinatiſque corporibus concreta hæc eſſe dicat, interjecto inani; ſomnia cenſet hæc eſſe *Democriti*, non docentis ſed optantis §."

‡ *De Nat. Deorum*, lib. i. cap. 1[illegible]

§ *Acad. Queſt.* lib. iv. cap. 3[illegible]

That the rough and ſmooth, and hooked and crooked, atoms of Democritus, were indeed dreams and dotages, is a poſition which no man will controvert; but ſurely Strato was himſelf as great a dreamer when he made ſenſation and intelligence reſult from a certain plaſtic or ſpermatic life in matter, which is itſelf devoid of ſenſe and conſciouſneſs. It is, indeed, inconceivable, to uſe the emphatic language of Cudworth, "how any one in his ſenſes ſhould admit ſuch a monſtrous paradox as this, that every atom of duſt has in itſelf as much wiſdom as the greateſt politician and moſt profound philoſopher, and yet is neither conſcious nor intelligent!" It is to be obſerved of Strato likewiſe, that though he attributed a certain kind of life to matter, he by no means allowed of one common life as ruling over the whole material univerſe. He ſuppoſed the ſeveral parts of matter to have ſo many ſeveral plaſtic lives of their own, and ſeems ‡ to have attributed ſomething to chance in the production and preſervation of the mundane ſyſtem.

‡ *Cud. In[illegible] Syſt. ed. Moſheim*, lib. i. cap[illegible]

In denying the exiſtence of a God, perpetually directing his plaſtic principle, and in ſuppoſing as many of theſe principles as there are atoms of matter, Strato deviated far from the doctrine of Ariſtotle. The great founder of the peripatetic ſchool, as well as his apoſtate diſciple, taught that mundane things are not effected by fortuitous mechaniſm, but by ſuch a *nature* as acts regularly and artificially for *ends*; yet he never conſiders this *nature* as the higheſt principle, or ſupreme *Numen*, but as ſubordinate to a perfect mind or intellect; and he expreſsly affirms, that "*mind*, together with *nature*, formed or faſhioned this univerſe." He evidently conſiders mind as the principal and intelligent agent, and nature as the ſubſervient and executive inſtrument. Indeed, we are ſtrongly inclined to adopt the opinion of the learned Moſheim, who thinks that by nature Ariſtotle meant nothing more than that θερμοτης ψυχικη, or *animal heat*, to which he attributes immortality, and of which he expreſsly ſays ‡ that all things are full. Be

‡ *De Ge[illegible]ratione A[illegible]nimal.* lib. iii. cap. 1[illegible]

Plaſtic.

this as it may, he always joins God and nature together, and affirms that they do nothing in vain. The ſame doctrine was taught before him by Plato, who affirms that "nature, together with reaſon, and according to it, orders all things." It muſt not, however, be concealed, that Plato ſeems to have attributed intelligence to the principle by which he ſuppoſed the world to be animated; for Chalcidius, commenting on the Timæus ‡, thus expreſſes himſelf: "Hæc eſt illa *rationabilis* anima mundi, quæ gemina juxta meliorem naturam veneratione tutelam præbet inferioribus, divinis diſpoſitionibus obſequens, providentiam nativis impertiens, æternorum ſimilitudine propter cognationem beata."—Apuleius, too, tells us ||, "Illam cœleſtem animam, fontem animarum omnium, optimam virtutem eſſe genetricem, ſubſerviri etiam Fabricatori Deo, et præſto eſſe ad omnia inventa ejus." *Plato pronunciat.*

‡ Sect. 53.

|| De Dogmate Platonis.

This doctrine of Plato has been adopted by many moderns of great eminence both for genius and for learning. The celebrated Berkeley biſhop of Cloyne, after giving the view of Plato's *anima mundi*, which the reader will find in our article MOTION, n° 10, thus recommends the ſtudy of his philoſophy *: "If that philoſopher himſelf was not read only, but ſtudied alſo with care, and made his own interpreter, I believe the prejudice that now lies againſt him would ſoon wear off, or be even converted into high eſteem, for thoſe exalted notions, and fine hints, that ſparkle and ſhine throughout his writings; which ſeem to contain not only the moſt valuable learning of Athens and Greece, but alſo a treaſure of the moſt remote traditions and early ſcience of the eaſt." Cudworth, and the learned author of *Ancient Metaphyſics*, are likewiſe ſtrenuous advocates for the Ariſtotelian doctrine of a plaſtic nature diffuſed through the material world; (ſee METAPHYSICS, n° 200, 201, 202.): and a notion very ſimilar has lately occurred to a writer who does not appear to have borrowed it either from the *Lyceum* or the *Academy*.

* Siris, n° 338.

This writer is Mr Young, of whoſe *active ſubſtance*, and its agency in moving bodies, ſome account has been given elſewhere, (ſee MOTION). As a mere unconſcious agent, *immaterial*, and, as he expreſſes himſelf, *immental*, it bears a ſtriking reſemblance to the *plaſtic nature* or *vegetable life* of Cudworth: but the author holds it to be not only the principle of motion, but alſo the *baſis* or *ſubſtratum* of matter itſelf; in the production of which, by certain motions, it may be ſaid to be more ſtrictly *plaſtic* than the *hylarchical* principle, or *vis genitrix*, of any other philoſopher with whoſe writings we have any acquaintance. Though this opinion be ſingular, yet as its author is evidently a man who thinks for himſelf, unawed by the authority of celebrated names, and as one great part of the utility of ſuch works as ours conſiſts in their ſerving as indexes to ſcience and literature, we ſhall lay before our readers a ſhort abſtract of the reaſonings by which Mr Young endeavours to ſupport his hypotheſis, and we ſhall take the liberty of remarking upon thoſe reaſonings as we proceed.

The author, after a ſhort introduction, enters upon his work ‡, in a chapter intitled, *Analyſis of Matter in general*. In that chapter there is little novelty. He treats, as others have done, of primary and ſecondary qualities, and adheres too cloſely to the language of Locke, when he ſays, that "the nature of bodies ſignifies the aggregate of all thoſe *ideas* with which they furniſh us, and by which they are made known." To ſay the beſt of it, this ſentence is inaccurately expreſſed. An aggregate of *ideas* may be occaſioned by the impulſe of bodies on the organs of ſenſe, but the effect of impulſe cannot be that which impels. We ſhould not have made this remark, which may perhaps be deemed captious, were we not perſuaded that the vague and inaccurate uſe of terms is the ſource of thoſe miſtakes into which, we cannot help thinking, that the very ingenious author has ſometimes fallen. Having juſtly obſerved, that we know nothing directly of bodies but their qualities, he proceeds to inveſtigate the nature of ſolidity.

‡ An Eſſay on the powers and mechaniſm of nature.

Plaſtic.

"Solidity (he ſays) is the quality of body which principally requires our notice. It is that which fills extenſion, and which reſiſts other ſolids, occupying the place which it occupies; thus making extenſion and figure real, and different from mere ſpace and vacuity. If the ſecondary qualities of bodies, or their powers, variouſly to affect our ſenſes, depend on their primary qualities, it is chiefly on this of ſolidity; which is therefore the moſt important of the primary qualities, and that in which the eſſence of body is by ſome conceived to conſiſt. This idea of ſolidity has been judged to be incapable of any analyſis; but it appears evident to me (continues our author), that the idea of ſolidity may be reſolved into another idea, which is that of the power of reſiſting within the extenſion of body. Hence it becomes unneceſſary, and even inadmiſſible, to ſuppoſe that ſolidity in the body is at all a pattern or archetype of our ſenſation."

That ſolidity in the body, and we know nothing of ſolidity any where elſe, is no pattern of any ſenſation of ours, is indeed moſt true, as we have ſhown at large in another place, (ſee METAPHYSICS, n° 44 and 171): but to reconcile this with what our author aſſerts immediately afterwards, that "ſolidity is no more in bodies than colours and flavours are, and that it is equally with them a *ſenſation* and an *idea*," would be a taſk to which our ingenuity is by no means equal. He affirms, indeed, that ſolidity, as it is ſaid to be in bodies, is utterly incomprehenſible; that we can perfectly comprehend it as a ſenſation in ourſelves, but that in bodies nothing more is required than a power of active reſiſtance to make upon our ſenſes thoſe impreſſions from which we infer the reality of primary and ſecondary qualities. This power of reſiſtance, whether it ought to be called active or paſſive, we apprehend to be that which all other philoſophers have meant by the word *ſolidity*; and though Locke, who uſes the words *idea* and *notion* indiſcriminately, often talks of the *idea* of ſolidity, we believe our author to be the firſt of human beings who has thought of treating *ſolidity* as a ſenſation in the mind.

Though it is wrong to innovate in language, when writing on ſubjects which require much attention, we muſt, however, acknowledge it to be unworthy of inquirers after truth to diſpute about the proper or improper uſe of terms, ſo long as the meaning of him who employs them can be eaſily diſcovered. We ſhall, therefore, follow our author in his endeavours to aſcertain what this power of reſiſtance is which is commonly known by the name of ſolidity. All power he juſtly holds to be active; and having, by an argument (A) of which we do not

"(A) We can only conceive of ſolidity as being a reſiſtance of the *parts* of any body, to a power which endeavours

Plastic. not perceive the force, attempted to prove that it is by an inward *power*, and not by its *inertia*, that one body prevents another from occupying the same place with itself, he naturally enough infers matter to be essentially active. "But the activity of matter is to be considered in a certain limited sense, and its inertness is to be regarded in another limited sense; so that these are compatible within their respective limits. The activity of body may be considered as belonging to the parts of a compound; its inertia as the inertia formed of those parts. The actions of the parts are everywhere opposed to each other, and equal; and hence results the inactivity of the whole."

Solidity alone of the primary qualities being positive, and peculiar to bodies, and our author having resolved this into action or power, it follows, by his analysis, that the essence of body is reduced to power likewise. But, as he properly observes, power is an idea of reflection, not acquired by the senses, but suggested by thought. Hence our knowledge of real existence in body must be such as is suggested to us by our thoughts exercised about our sensations. "We are capable of acting and producing changes in appearances; and this faculty, which we experience to exist in ourselves, we call power. We are conscious of the exertion of our own power; and therefore, when we see action or change happen without any exertion of ours, we refer this to other powers without us, and necessarily conclude the power to exist where the change begins or the action is exerted. This power, then, referred to bodies, must exist in them, or it can exist no where."

In two chapters, which might easily have been compressed into one not so long as the shortest of them, our author analyzes *atoms* or the primary particles of matter, and strenuously opposes their impenetrability. He allows that there are atoms of matter not divisible by any known force; but as these, however small, must still be conceived as having extension, each of them must be composed of parts held together by the same power which binds together many atoms in the same body. This power, indeed, he acknowledges to operate much more forcibly when it cements the parts of a primary atom than when it makes many atoms cohere in one mass; but still it operates in the same manner: and as the ideal analysis may be carried on *ad infinitum*, the only positive idea which is suggested by atoms, or the parts of atoms, is the idea of a resisting power. That this power of resistance, which constitutes what is vulgarly called the solidity of bodies, may not be absolutely impenetrable, he attempts to prove, by showing that resistance does in fact take place in cases where impenetrability, and even solidity, are not supposed by any man.

"Let us endeavour (says he) to bring together two like poles of a magnet, and we shall experience a resistance to their approximation. Why, then, may not a piece of iron, which between our fingers resists their coming together, resist by an efficacy perfectly similar, though more strongly exerted? If magnetism were to act upon our bodies as upon iron, we should feel it; or were magnets endowed with sensation, they would feel that which resists their nearer approach. The resisting extension between the two magnets is permeable to all the rays of light, and reflecting none is therefore unseen; but it is easy to conceive that the same power which resists the approach of the iron might resist and reflect some rays of light. We should then have a visible object interposed between the two magnets, as we have before supposed it might be a tangible one. It is likewise easy to conceive that which is tangible and visible so applied to our organs of tasting, of smelling, and of hearing, as to excite ideas of flavours, odours, and sounds. Thus we see that an action, in which no supposition of solidity or impenetrability is involved, may be conceived to assume all the qualities of matter, by only supposing a familiar effect extended in its operation."

This reasoning is exceedingly ingenious, though perhaps not original; but what is of more importance, it does not approach so near to demonstration as the author seems to imagine. If magnets operate by means of a fluid issuing from them (see Magnetism, chap. 3.), those who hold the solidity or impenetrability of matter will maintain, that each atom of the magnetic fluid is solid and impenetrable. That we do not see nor feel these atoms, will be considered as no argument that they do not exist; for we do not see, nor in a close room feel, the atoms of the surrounding atmosphere; which yet Mr Young will acknowledge to have a real existence, and to be capable of operating upon our senses of hearing and smelling. Let us, however, suppose, that by this reasoning

---

vours to *separate* them, or to bring them *nearer* together. Now that which resists any power, and prevents its effect, is also a power. By resistance, I mean here an active resistance, such as an animal can employ against an animal. If a horse pulls against a load, he draws it along; but if he draws against another horse, he is put to a stand, and his endeavour is defeated. When any endeavour to change the situation of the parts of any solid is in like manner prevented from taking effect, and the parts retain their situation, the situation has plainly been preserved by an active resistance or power, equivalent to that which was fruitlessly exerted on them."

Such is our author's reasoning to prove that matter is essentially active, and that from this activity results our notion of its solidity: but does he not here confound solidity with hardness, and impenetrability with cohesion? He certainly does; for *water* is as *solid*, in the proper sense of the word, as *adamant*, and the particles of *air* as the particles of *iron*. The parts of water are, indeed, separated with ease, and those of adamant with difficulty; but it is not because the latter have more solidity than the former, but because the power of cohesion, whatever it may be, operates upon them with greater force. Solidity is an attribute of a whole; hardness and softness results from the cohesion of parts. We do not at all perceive the propriety of the simile of the horse pulling a load, and afterwards pulling against another horse. Is it because both horses are *active* that one of them cannot prevail against the other, and because the load is *inactive* that either of them may drag along a mass of iron of half a tun weight? If so, double or triple the mass, and a very strange phenomenon will be the result; for we shall have an active whole compounded of two or three inactive parts, even though those parts should not be in contact!

Plastic.

reasoning he has established the non-existence of every thing in the primary atoms of matter but active powers of resistance, and let us see how he conceives the actions of these powers to constitute what gives us the notion of inert and solid body; for that we have such a notion cannot be denied.

To ACT he allows to be an attribute, and justly observes, that we cannot conceive an attribute to exist without a substance. "But (says he) we have traced all phenomena to action as to a generic idea, comprehending under it all forms of matter and motion as species of that genus. By this analysis, that complex idea we have usually denominated matter, and considered as the substance or substratum to which motion appertained as an attribute, is found to change its character, and to be itself an attribute of a substance essentially active, of which one modification of motion produces matter and another generates motion." The action of this substance Mr Young determines to be motion (see MOTION, n° 16.); and he proceeds to inquire by what kind of motion it produces matter, or inert and resisting atoms.

"Whatever portion of the ACTIVE SUBSTANCE is given to form an atom, the following things are necessary to be united in such portion of active substance: *1st*, It must in some respect continually move; for otherwise it would lose its nature, and cease to be active. *2dly*, It must also in some other respect be at rest, for otherwise it could not form an inactive atom. *3dly*, It must preserve unity within itself." The author's proof of the first of these positions we have given elsewhere. The second he holds to be self-evident; and the third he thinks established by the following reasoning: "Solidity is the result of those actions among the parts of any whole, whereby the unity of the whole is preserved within itself. Several uncohering things may be united by an external bond: this does not constitute these one solid; it may be one bundle: but if several things cohere, and have a unity preserved within themselves, they become one solid. An atom is the least and most simple solid."

Having thus proved the necessity of these three requisites to the formation of an atom, he observes, that "the two first can only be united in a rotation of the portion of active substance about a centre or axis at rest. By such a motion, *all the parts* successively occupy *different places* in the orbit of rotation, and therefore move; the centre round which they revolve being at rest, the *whole portion* is also at rest; and thus the portion is at once moving and quiescent, as is required. The same kind of motion will also fulfil the terms of the third requisite; for a substance having a revolving motion around its own centre, preserves its unity by reason of all the parts preserving the same relation to the centre: and further, a motion of the active substance about a centre or axis will be an activity in the same orbit, which will act upon and resist whatever shall interfere to oppose its activity, or destroy the unity of the sphere, by diverting the course of the revolving motions. The activity or motion of a portion of ACTIVE SUBSTANCE about a centre will, therefore, give solidity to such portion; for it will give it unity and resistance, and in a manner tie together all the parts, forming them into one mass about their common centre: for they move or are active not *towards* the centre, in which case they would be lost in non-extension; nor *from* the centre, where they would dissipate in boundless space; but *about* the centre, preserving the same limits of extension: and being in this way active, they in this way resist any other activity opposed to them, that is, they resist any action which tends to penetrate or divide this sphere of revolving activity. Therefore, since any portion of active substance does, by revolving about a centre, become an united, resisting, and quiescent whole, the smallest portions of the ACTIVE SUBSTANCE which have such motions will become *atoms*, or make the smallest portions of matter."

Having thus shown to his own satisfaction how atoms of matter are formed, he next explains what at first he confesses may have appeared a paradox, "how the ACTIVE SUBSTANCE, retaining its own nature and essential properties, continuing immaterial, unsolid, and active, puts on at the same time the form of matter, and becomes material, solid, and inert. A sphere of revolving active substance, as it revolves continually about a centre, and as parts of the substance, are considered as successively passing through every point in the orbit; considered thus in its parts, and in its motions, it is ACTIVE SUBSTANCE, immaterial, and unsolid; but the whole sphere, considered unitically, collectively, and as quiescent, is in this point of view a solid atom, material, and inert."

Such is the active substance of Mr Young, and such his theory of the formation of matter. That he has not with servility copied from the ancients, every reader of his book, who is not an absolute stranger to Greek and Roman literature, will readily acknowledge; and yet if his theory be well founded, he has discovered a middle substance between mind and matter, more properly *plastic* than Aristotle or Plato, Cudworth or Berkeley, ever conceived. But truth compels us to add, that to us his theory appears to labour under insuperable objections. That there *may* be in the universe a substance essentially active, and at the same time not intelligent, is a proposition which we are by no means inclined to controvert. Various phenomena, both in vegetable and animal life, lead us to suspect that there is such a substance; but it does not follow that we are inclined to adopt our author's doctrine respecting the formation of matter. He conceives his proof, indeed, to be "in its nature not at all imperfect, or to fall short of demonstration; and if any one refuse it, he thinks it will be necessary for him to show, either that the explanation offered is not sufficient, or that some other explanation will serve equally well."

To show that the explanation offered is not sufficient, will not, we apprehend, be a very arduous task; but we have no inclination to attempt ourselves another explanation, because we believe that of the formation of matter no other account can be given than that which resolves it into the *fiat* of the Creator. That it cannot be formed by the motion of an immaterial substance in the manner which our author has very clearly described, seems to be a truth so evident as not to admit of proof; for if motion be, as he defines it, a change of place, every thing that is moved must have the quality of extension. But all the parts of this active substance which are given to form an atom, move round a centre, and are expressly said to occupy successively different *places* in the orbit of rotation. Every one of these parts, therefore, is an extended being: and since, according to our

author,

author, ſolidity is nothing but an *active power of reſiſtance*, and the parts of this active ſubſtance, in their rotation round their centre, *act upon* and *reſiſt* whatever interferes to oppoſe their activity, it follows that each of theſe parts is likewiſe a *ſolid being*. But, in the opinion of Mr Young himſelf, and of all mankind, whatever is extended and ſolid is material. This theory, therefore, exhibits a proceſs in which atoms are formed of a ſubſtance, which, though it is ſaid to be *active*, *immaterial*, and unſolid, appears, when narrowly inſpected, to be nothing elſe than a collection of thoſe very atoms of which the author pretends to explain the formation. Mr Young, who examines and very freely cenſures ſome of the doctrines of Newton and others, is too much a man of ſcience to be offended at us for ſtating objections to a theory which is quite new, to a transformation which he himſelf acknowledges may to many "appear not only problematical and difficult to conceive, but wholly impoſſible, and implying contradictions abſolutely and for ever irreconcileable." Whether this be a juſt character of it our readers muſt determine; but if we did not believe the author to be a man of ingenuity, we ſhould not have introduced him or his work to their acquaintance.

Plastic Art, the art of repreſenting all ſorts of figures by the means of moulds. This term is derived from the Greek word πλαστικη, which ſignifies the "art of forming, modelling, or caſting, in a mould." A mould in general is a body that is made hollow for that purpoſe. The artiſt makes uſe of them to form figures in bronze, lead, gold, ſilver, or any other metal or fuſible ſubſtance. The mould is made of clay, ſtucco, or other compoſition, and is hollowed into the form of the figure that is to be produced; they then apply the jet, which is a ſort of funnel, through which the metal is poured that is to form the figures, and that is called *running the metal into the mould*.

It is in this manner, but with much practice and attention, that the artiſt forms, 1. Equeſtrian and pedeſtrian ſtatues of every kind; 2. Groups; 3. Pedeſtals; 4. Baſs-reliefs; 5. Medallions; 6. Cannons, mortars, and other pieces of artillery; 7. Ornaments of architecture, as capitals, baſes, &c.; 8. Various ſorts of furniture, as luſtres, branches, &c. in every kind of metal: and in the ſame manner figures are caſt in ſtucco, plaſter, or any other fuſible matter. See *Plaster of Paris*.

Wax being a ſubſtance that is very eaſily put in fuſion, plaſtics make much uſe of it. There are impreſſions which are highly pleaſing in coloured wax, of medallions, baſſo and alto relievos, and of detached figures; which, however, are ſomewhat brittle. But this matter has been carried too far: they have not only formed moulds to repreſent the likeneſs and the buſt of a living perſon, by applying the plaſter to the face itſelf, and afterwards caſting melted wax into the mould; but they have alſo painted that waxen buſt with the natural colours of the face, and have then applied glaſs eyes and natural hair; to which they have joined a ſtuffed body and limbs, with hands of wax; and have, laſtly, dreſſed their figure in a real habit; and by theſe means have produced an object the moſt ſhocking and deteſtable that it is poſſible to conceive. It is not a ſtatue, a buſt, a natural reſemblance that they form; but a dead body, a lifeleſs countenance, a mere carcaſe. The ſtiff air, the inflexible muſcles, the haggard eyes of glaſs, all contribute to produce an object that is hideous and diſguſtful to every man of taſte. Figures like theſe offend by affording too exact an imitation of nature. In no one of the polite arts ought imitation ever to approach ſo near the truth as to be taken for nature herſelf. Illuſion muſt have its bounds; without which it becomes ridiculous.

There is another invention far more ingenious and pleaſing, which is that wherein M. Lippart, antiquary and artiſt at Dreſden, has ſo much excelled. He has found the means of reſembling, by indefatigable labour, great expence, and infinite taſte, that immenſe number of ſtones, engraved and in camaieu, which are to be ſeen in the moſt celebrated cabinets. He has made choice of thoſe that are the moſt beautiful; and, with a paſte of his own invention, he takes from theſe ſtones an impreſſion that is ſurpriſingly accurate, and which afterwards become as marble: theſe impreſſions he calls *paſti*. He then gives them a proper colour, and incloſes each with a gold rim; and, by ranging them in a judicious order, forms of them an admirable ſyſtem. They are fixed on paſteboards, which form ſo many drawers, and are then incloſed in caſes, which repreſent folio volumes, and have titles wrote on their backs; ſo that theſe fictitious books may conveniently occupy a place in a library. Nothing can be more ingenious than this invention; and, by means of it, perſons of moderate fortune are enabled to make a complete collection of all antiquity has left that is excellent of this kind; and the copies are very little inferior to the originals.

There is alſo another method of taking the impreſſions of camaieus, medals, and coins, which is as follows: They waſh or properly clean the piece whoſe impreſſion is to be taken, and ſurround it with a border of wax. They then diſſolve iſinglaſs in water, and make a decoction of it, mixing with it ſome vermilion, to give it an agreeable red colour. They pour this paſte, when hot, on the ſtone or medal, to the thickneſs of about the tenth part of an inch; they then leave it expoſed to the ſun, in a place free from duſt. After a few days this paſte becomes hard, and offers to the eye the moſt admirable and faithful repreſentation of the medal that it is poſſible to conceive: they are then carefully placed in drawers; and thouſands of theſe impreſſions, which comprehend many ages, may be included in a ſmall compaſs.

The proficients in plaſtics have likewiſe invented the art of caſting in a mould papier maché or diſſolved paper, and forming it into figures in imitation of ſculpture, of ornaments and decorations for ceilings, furniture, &c. and which they afterwards paint or gild. There are, however, ſome inconveniences attending this art; as, for example, the imperfections in the moulds, which render the contours of the figures inelegant, and give them a heavy air: theſe ornaments, moreover, are not ſo durable as thoſe of bronze or wood, ſeeing that in a few years they are preyed on by the worm.

The figures that are given to porcelain, Delft ware, &c. belong alſo to plaſtics; for they are formed by moulds, as well as by the art of the ſculptor and turner; and by all theſe arts united are made vaſes of every kind, figures, groups, and other deſigns, either for uſe or ornament.

From this general article the reader is referred to Foundery, Cast, Glazing, Porcelain, *Papier-Maché*, Pottery, *Delft Ware*.

PLATA,

Plata.

PLATA, the name of a very great river of South America, running through the province of Paraguay; whence the whole country is ſometimes called *Plata;* though this name is uſually beſtowed only upon a part of Paraguay. In the latter ſenſe it comprehends all that country bounded on the eaſt and ſouth-eaſt by the Atlantic Ocean; on the ſouth, by Terra Magellanica; on the weſt, by Tucuman; and on the north, by the provinces of Paraguay Proper and Parana. The great river La Plata, from which the country has its name, was firſt diſcovered, in 1515, by Juan Diaz de Solis; but denominated *La Plata* by Sebaſtian Gabato, from the great quantity of the precious metals he procured from the adjacent inhabitants, imagining it was the produce of the country, though in fact they brought it from Peru.

The country lies between 32° and 37° of ſouth latitude. The climate is pleaſant and healthy. Their winter is in May, June, and July, when the nights are indeed very cold, but the days moderately warm; the froſt is neither violent nor laſting, and the ſnows are very inconſiderable.

The country conſiſts moſtly of plains of a vaſt extent, and exceeding rich ſoil, producing all ſorts of European and American fruits, wheat, maize, cotton, ſugar, honey, &c. and abounding with ſuch excellent paſtures, that the beaſts brought hither from Spain are multiplied to ſuch a degree, that they are all in common, no man claiming any property in them, but every man takes what he hath occaſion for. The number of black cattle, eſpecially, is ſo prodigious, that many thouſands of them are killed merely for their hides, every time the ſhips go for Spain, and their carcaſes left to be devoured by wild beaſts and birds of prey, which are alſo very numerous. Sometimes, when they cannot vend their hides, they will kill them for their tongues; and thoſe who care not to be at the trouble to fetch them from the plains, may buy them for a trifle. There is a curious account in Lord Anſon's voyage of the manner of hunting them on horſeback; and of catching and killing them, by throwing a nooſe on their horns at full gallop, the horſes being trained to the ſport. Horſes are no leſs numerous, and in common like the other cattle; ſo that a man may have as many as he pleaſes for the catching; and of thoſe that are already broke, one may buy ſome of the beſt, and of the true Spaniſh breed, for a piece-of-eight per head. Wild-fowl alſo is in great plenty here; partridges in particular are more numerous, and as large and tame as our hens, ſo that one may kill them with a ſtick. Their wheat makes the fineſt and whiteſt of bread; and, in a word, they ſeem to want for nothing here, eſpecially the natives, but ſalt and fuel. The former the Spaniards have brought to them from other parts; and the latter they ſupply themſelves with, by planting vaſt numbers of almond, peach, and other trees, which require no other trouble than putting the kernels into the ground, and by the next year, we are told, they begin to bear fruit. The return for European commodities is ſo great here, that it almoſt exceeds belief; an ordinary two-penny knife fetching a crown, and a gun of the value of 10 or 12 ſhillings 20 or 30 crowns, and ſo of the reſt.

The river Plata riſes in Peru, and receives a great many others in its courſe; the chief of which is the Paraguay. The water of it is ſaid to be very clear and ſweet, and to petrify wood; and contains ſuch plenty and variety of fiſh, that the people catch great quantities of them without any other inſtrument than their hands. It runs moſtly to the ſouth and ſouth-eaſt; and is navigable the greater part of its courſe by the largeſt veſſels, and full of delightful iſlands. All along its banks are ſeen the moſt beautiful birds of all kinds; but it ſometimes overflows the adjacent country to a great extent, and is infeſted by ſerpents of a prodigious bigneſs. From its junction with the Paraguay to its mouth is above 200 leagues. We may form ſome judgement of its largeneſs by the width of its mouth, which is ſaid to be about 70 leagues. Before it falls into the Paraguay it is called *Panama*. See Panama.

Platææ, Platalea.

PLATÆÆ (anc. geog.), a very ſtrong town of Bœotia, in its ſituation expoſed to the north wind (Theophraſtus); burnt to the ground by Xerxes (Herodotus, Juſtinus); mentioned much in the courſe of the Perſian war: Famous for the defeat of Mardonius, the Perſian general; and for the moſt ſignal victory of the Lacedemonians and other Greeks under Pauſanias the Lacedemonian, and Ariſtides an Athenian general (Nepos, Diodorus, Plutarch); in memory of which the Greeks erected a temple to Jupiter Eleutherius, and inſtituted games which they called *Eleutheria;* and there they ſhow the tombs of thoſe who fell in that battle (Strabo). It ſtood at the foot of mount Cithæron, between that and Thebes to the north, on the road to Athens and Megara, and on the confines of Attica and Megaris. Now in ruins.

PLATALEA, the Spoonbill, in ornithology, a genus belonging to the order of grallæ. The beak is plain, and dilates towards the point into an orbicular form; the feet have three toes, and are half palmated. Plate CCCXCVII. There are three ſpecies diſtinguiſhed by their colour: and of theſe ſpecies there are three varieties; two of what is called the *white ſpecies*, and one of the *roſeate*.

1. The white ſpecies, which Linnæus calls *platalea leucorodia*, is about the ſize of a heron, but ſomewhat ſhorter in the neck and legs. The bill is more than half a foot long, and, like that of the reſt of the genus, is ſhaped like a ſpoon: the colour of the bill is very various, being in ſome birds black, in others brown, and ſometimes ſpotted; from the baſe to two-thirds of its length ſeveral indentations croſs it, the riſing parts of which are of a dark colour: the tongue is ſhort and heart-ſhaped: the irides are grey: the ſkin of the lore round the eyes and of the throat is bare and black: the plumage is entirely white, though there have been ſpecimens where the quills were tipped with black: the legs are generally either black or of a greyiſh brown colour; between the toes there is a membrane connected to the outer one as far as the ſecond, and to the inner as far as the firſt joint.

"This bird (ſays Mr Latham) is found in various parts of the old continent, and from the Ferro iſles near Iceland to the Cape of Good Hope. It frequents the neighbourhood of the ſea; and has been met with on the coaſts of France; at Sevenhuys, near Leyden, once in great plenty, annually breeding in a wood there. The neſt is placed on high trees near the ſea-ſide. The female lays three or four white eggs, powdered with a few pale red ſpots, and of the ſize of thoſe of an hen. They are very noiſy during breeding-time, like our rooks; are ſeldom found high up the rivers, chiefly frequenting

the

Platalea, Platanus.

the mouths of them. Their food is fiſh, which they are ſaid not unfrequently to take from other birds, in the manner of the bald eagle; alſo muſſels and other ſhell-fiſh being found in greateſt numbers where theſe are plenty; and they will alſo devour frogs and ſnakes, and even graſs and weeds, which grow in the water, as well as the roots of reeds. They are migratory, retiring to the warmer parts as the winter approaches, and are rarely ſeen in England. Their fleſh is ſaid to have the flavour of a gooſe, and is eaten by ſome, and the young birds have been thought good food. By many authors they are called *pelicans*."

The two varieties of this ſpecies are equal in ſize to the roſeate ſpecies. The bill of the firſt is reddiſh; the plumage moſtly white; the feathers of the wings partly white and partly black, and the legs reddiſh. The plumage of the other is entirely white, not excepting even the quills. It has a creſt of feathers whoſe webs are very looſe, and ſeparated from one another; the bill is of a rufous grey colour, having red edges, and the legs are of a dull pale red. They both inhabit the *Philippine iſlands.*

2. The roſeate ſpecies, or *platalea ajaja*, is but a little leſs than the white. The bill is marked all round with a furrow parallel to the edge, and is of a greyiſh white colour, ſo tranſparent as to ſhow the ramification of the blood-veſſels belonging to it: the forehead is of a whitiſh colour between the bill, and eyes, and throat: the plumage is a fine roſe-colour, deepeſt on the wings: the legs are grey; the claws blackiſh; and the toes have membranes as in the laſt ſpecies. The variety of this ſpecies is entirely of a beautiful red colour, having a collar of black at the lower part of the neck; the irides are red. Mr Latham imagines it is the roſeate in full plumage. It is ſaid to be of a blackiſh cheſnut the firſt year; becomes roſe-coloured the ſecond, and of a deep ſcarlet the third. It lives on ſmall fiſh.

3. The dwarf ſpecies, or *platalea pigmea*, is about the ſize of a ſparrow. The bill is black, longer than the head, flat at the end, and nearly of a rhomboidal form; the angles and top of the upper mandible are white; the tongue is ſmooth; the body is brown above and white beneath; the quills have white ſhafts; the tail is rounded, ſhort, and of a browniſh white colour; the feet have four toes, are cloven, and the claws are pointed. It inhabits Surinam and Guiana.

PLATANUS, the PLANE-TREE; a genus of the polyandria order, belonging to the monœcia claſs of plants.

Species. 1. The orientalis, oriental or eaſtern plane-tree, riſes with a very ſtraight ſmooth branching ſtem to a great height. It has palmated leaves, ſix or eight inches long and as much broad, divided into five large ſegments, having the ſide ones cut into two ſmaller, green above, and pale underneath; and long pendulous pedunculi, each ſuſtaining ſeveral round heads of cloſe-ſitting very ſmall flowers; ſucceeded by numerous downy ſeeds, collected into round, rough, hard balls. It is a native of Aſia and many parts of the eaſt, and grows in great plenty in the Levant. 2. The occidentalis, occidental, or weſtern plane-tree, riſes with a ſtraight ſmooth ſtem, to a great height, branching widely round: it has lobated leaves, ſeven or eight inches long, and from nine or ten to twelve or fourteen broad, divided into three large lobes; and very ſmall flowers, collected into round heads, ſucceeded by round rough balls of ſeed. It is a native of Virginia and other parts of North America; where it attains an enormous ſize, and is remarkable for having its ſtem all of an equal girt for a conſiderable length: we have an account of ſome trees being eight or nine yards in circumference, and which, when felled, afforded 20 loads of wood. The varieties of theſe two ſpecies are the Spaniſh or middle plane-tree, having remarkably large leaves of three or five narrower ſegments; and the maple-leaved plane-tree, having ſmaller leaves, ſomewhat lobated into five ſegments, reſembling the mapple-tree leaf.

All theſe elegant trees are of hardy temperature, ſo as to proſper here in any common ſoil and expoſure in our open plantations, &c. and are ſome of the moſt deſirable trees of the deciduous tribe. They were in ſingular eſteem among the ancients of the eaſt, for their extraordinary beauty, and the delightful ſhade they afforded by their noble foliage. The leaves commonly expand in May, and fall off early in autumn; and the flowers appear in ſpring, a little before the leaves, being ſucceeded by ſeeds, which in fine ſeaſons frequently ripen here in September. Theſe fine trees are ſingularly fitted for all ornamental plantations. Their ſtraight growth, regular branching heads, and the lofty ſtature they attain, together with the extraordinary breadth of their luxuriant leaves, render them extremely deſirable furniture to adorn avenues, lawns, parks, and woods; ſome diſpoſed in ranges, ſome as ſingle ſtandards, others in clumps, ſome in groves, &c. They are moſt excellent for ſhade; for it is obſervable, that no tree is better calculated to defend us from the heat in ſummer, by its noble ſpreading foliage, and to admit the ſun's rays more freely in winter, on account of the diſtance of its branches, which is always in proportion to the ſize of the leaves. They may alſo be employed in the collection of foreſt-trees, in woods, to grow up to timber, in which caſe they will alſo prove advantageous in time. In ſhort, theſe noble trees claim the eſteem of every one concerned in plantations of every kind; but more particularly in extenſive ones, where they may be ſo variouſly diſpoſed as to have a charming effect.

The *propagation* of theſe trees is by ſeed, layers, and cuttings. The ſeeds frequently ripen in theſe parts, and are alſo procured from other countries, and may be obtained of the nurſerymen or ſeedſmen. The beſt ſeaſon for ſowing them is autumn, if they can be then poſſibly procured. Chooſe a ſomewhat ſhady moiſt ſoil; and having dug the ground, and raked it fine, form it into four-feet wide beds, and either ſcatter the ſeeds evenly on the ſurface and rake them in, or previouſly with the back of a rake turn the earth off the ſurface near half an inch deep into the alleys; then ſow the ſeed, and directly, with the rake turned the proper way, draw the earth evenly over the ſeeds, and trim the ſurface ſmooth: many of the plants will riſe in ſpring, and probably may not till the ſpring following. When they are one or two years old, plant them out in nurſery rows, two or three feet aſunder, and about half that diſtance in the lines; here to remain till of a proper ſize for final tranſplantation. The method of propagation by layers is very commonly practiſed in the nurſeries, in default of ſeed, and by which they moſt readily grow; for which purpoſe, ſome ſtout plants for ſtools muſt be planted, which in a year after muſt be headed down

near the bottom, that they may throw out many ſhoots near the ground, convenient for laying; which, in the autumn after they are produced, lay by for ſlit-laying; and by autumn after, they will be well rooted, and form plants two or three feet high, ſo may be ſeparated, and planted in nurſery-rows like the ſeedlings. All the ſorts will take tolerably by cutting off the ſtrong young ſhoots; but the *platanus occidentalis* more freely than the oriental kind. Autumn is the beſt ſeaſon: as ſoon as the leaf falls, chooſe ſtrong young ſhoots, and plant them in a moiſt ſoil; many of them will grow, and make tolerable plants by next autumn. It ſhould be remarked, that, in order to continue the diſtinction of the varieties more effectually, they ſhould be propagated either by layers or cuttings: for when raiſed from ſeed, thoſe of the reſpective ſpecies generally vary.

PLATBAND, in gardening, a border or bed of flowers, along a wall, or the ſide of a parterre, frequently edged with box, &c.

Platband of a door or window, is uſed for the lintel, where that is made ſquare, or not much marked.

PLATE, a term which denotes a piece of wrought ſilver, ſuch as the ſhallow veſſel off which meat is eaten. It is likewiſe uſed by our ſportſmen to expreſs the reward given to the beſt horſe at our races.

Sportſman's Dictionary. The winning a plate is not the work of a few days to the owner of the horſe; but great care and preparation is to be made for it, if there is any great dependence on the ſucceſs. A month is the leaſt time that can be allowed to draw the horſe's body clear, and to refine his wind to that degree of perfection that is attainable by art.

It is firſt neceſſary to take an exact view of his body, whether he be low or high in fleſh; and it is alſo neceſſary to conſider whether he be dull and heavy, or briſk and lively when abroad. If he appear dull and heavy, and there is reaſon to ſuppoſe it is owing to too hard riding, or, as the jockeys expreſs it, to ſome greaſe that has been diſſolved in hunting, and has not been removed by ſcouring, then the proper remedy is half an ounce of diapente given in a pint of good ſack; this will at once remove the cauſe, and revive the creature's ſpirits. After this, for the firſt week of the month, he is to be fed with oats, bread, and ſplit beans; giving him ſometimes the one and ſometimes the other as he likes beſt; and always leaving ſome in the locker, that he may feed at leiſure when he is left alone. When the groom returns at the feeding-time, whatever is left of this muſt be removed, and freſh given; by this means the creature will ſoon become high-ſpirited, wanton, and full of play. Every day he muſt be rode out an airing, and every other day it will be proper to give him a little more exerciſe; but not ſo much as to make him ſweat too much. The beans and oats in this caſe are to be put into a bag, and beaten till the hulls are all off, and then winnowed clean; and the bread, inſtead of being chipped in the common way, is to have the cruſt clean cut off. If the horſe be in good fleſh and ſpirits when taken up for its month's preparation, the diapente muſt be omitted; and the chief buſineſs will be to give him good food, and ſo much exerciſe as will keep him in wind, without overſweating him or tiring his ſpirits. When he takes larger exerciſes afterwards, towards the end of the month, it will be proper to have ſome horſes in the place to run againſt him. This will put him upon his mettle, and the beating them will give him ſpirits. This, however, is to be cautiouſly obſerved, that he has not a bloody heat given him for ten days or a fortnight before the plate is to be run for; and that the laſt heat that is given him the day before the race, muſt be in his clothes: this will make him run with greatly more vigour, when ſtripped for the race, and feeling the cold wind on every part.

In the ſecond week, the horſe ſhould have the ſame food, and more exerciſe. In the laſt fortnight, he muſt have dried oats, that have been hulled by beating. After this they are to be wetted in a quantity of whites of eggs beaten up, and then laid out in the ſun to dry; and when as dry as before, the horſe is to have them. This ſort of food is very light of digeſtion, and very good for the creature's wind. The beans in this time ſhould be given more ſparingly, and the bread ſhould be made of three parts wheat and one part beans. If he ſhould become coſtive under this courſe, he muſt then have ſome ale and whites of eggs beaten together; this will cool him, and keep his body moiſt.

In the laſt week the maſh is to be omitted, and barley-water given him in its place, every day, till the day before the race: he ſhould have his fill of hay; then he muſt have it given him more ſparingly, that he may have time to digeſt it; and in the morning of the race day he muſt have a toaſt or two of white bread ſoaked in ſack, and the ſame juſt before he is let out to the field. This is an excellent method, becauſe the two extremes of fullneſs and faſting are at this time to be equally avoided; the one hurting his wind, and the other occaſioning faintneſs that may make him loſe. After he has had his food, the litter is to be ſhook up, and the ſtable kept quiet, that he may be diſturbed by nothing till he is taken out to run.

PLATFORM, in the military art, an elevation of earth, on which cannon is placed to fire on the enemy; ſuch are the mounts in the middle of curtins. On the ramparts there is always a platform, where the cannon are mounted. It is made by the heaping up of earth on the rampart, or by an arrangement of madriers, riſing inſenſibly, for the cannon to roll on, either in a caſemate or on attack in the outworks. All practitioners are agreed, that no ſhot can be depended on, unleſs the piece can be placed on a ſolid platform; for if the platform ſhakes with the firſt impulſe of the powder, the piece muſt likewiſe ſhake, which will alter its direction, and render the ſhot uncertain.

Platform, in architecture, is a row of beams which ſupport the timber-work of a roof, and lie on the top of a wall where the entablature ought to be raiſed.

This term is alſo uſed for a kind of terrace or broad ſmooth open walk at the top of a building, from whence a fair proſpect may be taken of the adjacent country. Hence an edifice is ſaid to be covered with a platform, when it is flat at top, and has no ridge. Moſt of the oriental buildings are thus covered, as were all thoſe of the ancients.

Platform, or *Orlop*, in a man of war, a place on the lower deck, abaft the main-maſt, between it and the cockpit, and round about the main capſtan, where proviſion is made for the wounded men in time of action.

PLATINA is a metallic ſubſtance lately diſcovered. The name, which has an alluſion to its colour, is a diminutive of *plata*, and ſignifies "little ſilver." From its great ſpecific gravity, and other reſemblances which it

Platina.

it has to gold, it has been called *or blanc*, or *white gold;* from its refractory nature, *diabolus metallorum;* from ſome doubts entertained of its character as a metal, *juan blanco*, *white jack*, *white rogue*, or *white mock metal.* It has alſo received the appellation of the *eighth metal;* and, probably from ſome diſtrict which affords it, has gotten the name of *platina del Pinto.*

The firſt in Europe who mentioned it by its preſent name was Don Antonio Ulloa, a Spaniſh mathematician, who in 1735 accompanied the French academicians that were ſent by their ſovereign to determine the figure of the earth by meaſuring a degree of the meridian in Peru. In the relation of his voyage, which was publiſhed at Madrid in 1748, he ſays, that the golden mines in the territory of Choco had been abandoned on account of platina; which he repreſents as a hard ſtone not eaſily broken by a blow on the anvil, which could not be ſubdued by calcination, and from which the gold could not be extracted without much labour, much expence, and great difficulty.

The particular places of Choco where it is found are Novita and Citara; but in what quantity it is there to be met with is not aſcertained. The miners, diſcovering at an early period that it was a metal, had begun to employ it in adulterating their gold; and the court of Spain, it is ſaid, dreading the conſequences, took meaſures not only to prevent its exportation, but partly to conceal the knowledge of it from the world. It is reported in the Chemical Annals for July 1792, that when the gold is brought from Choco to be coined in the two mints of Santa-fe, in that of Bogota and Popayan, the gold undergoes a new examination, the platina that remains is carefully ſeparated, and being given to officers appointed by the king, they, as ſoon as a certain quantity is collected, carry it away, and before witneſſes throw it into the river Bogota, at two leagues diſtance from Santa-fe, or into the Cauca, about one league diſtant from Popayan.

In the Phyſical Journals for November 1785 we are told, that the primitive mines which produced it have not yet been diſcovered in any part of the globe, and that thoſe which furniſh it at preſent are of the ſecondary kind, being ſtrata of looſe earth waſhed down from the higher grounds. In theſe ſtrata the particles are reported to be from the ſize of a millet ſeed to that of a pea. The author of the account ſays, that he had ſome pieces which weighed from 15 to 20 grains; and adds, that on trying ſome of them between ſteel rollers in the preſence of Meſſrs Darcet and Tillet at Paris, they were perfectly laminated. He ſays alſo, that a native piece of platina was found nearly of a ſquare figure, and almoſt as large as a pigeon's egg, which was depoſited in the Royal Society of Biſcay. M. de Buffon, however, ſays expreſsly, that "a perſon of credit had aſſured him that platina is ſometimes found in large maſſes; and that he had ſeen a lump of it weighing no leſs than 20 lib. which had not been melted, but taken in that ſtate out of the mine." As to the ſmall particles, they are of a whiter colour than iron, with a ſmooth ſurface. Their figure is generally of an oblong form, very flat, rounded in the edge, and has been aſcribed to the hammering of the mills in which the gold is amalgamated.

The heterogeneous ſubſtances with which the platina is generally mixed are particles of gold, grains of quartz or cryſtal, ſome ſand of a browniſh hue, and ſome duſt of a dark colour obedient to the magnet, and which ſeems to be fragments of other irregular dark-coloured particles, which reſemble pieces of emery or loadſtone. Dr Ingenhouſz, however, ſays, that every particle even of ſome fine platina which he examined obeyed the magnet more or leſs, excepting ſome that were tranſparent and ſtony; and that theſe were all magnets in themſelves, or that each of theſe particles had two poles, which he could change at pleaſure by magnetic bars. In about 72 pounds weight of platina which was brought from Spaniſh America, M. Magellan found not only a large quantity of ferruginous ſand, but many pieces of vegetable ſtalks, a number of ſeeds, and ſome very ſmall red cryſtals like rubies. Theſe cryſtals being ſent to M. Achard of Berlin, he tried them as far as their minuteneſs and ſmall quantity would permit, and at laſt concluded that they really were rubies. As for the mercurial globules which are ſometimes intermixed with the particles of platina, they are entirely foreign to its mines. They are now generally thought to be part of the mercury that has been employed in amalgamation; and which could not be brought from a place leſs diſtant than Guancavelica, about 900 miles from the province of Choco where the platina is found.

This metal, though not under its preſent name, which was firſt mentioned by Don Ulloa, has perhaps been known in Europe ſince 1741. At that period Charles Wood found in Jamaica ſome platina which was brought from Carthagena. He even made ſome chemical trials of it. Among others, he attempted to cupel it; and obſerves, in the account which he gave of it in 1749, that the Spaniards had a method of caſting it into different ſorts of toys, which are common enough in the Spaniſh Weſt Indies. It was probably, too, imported into Spain ſoon after its diſcovery in America. It is ſaid that Rudenſchoel carried ſome of it from Spain to Stockholm in 1745; and the firſt important ſet of experiments that appeared on the ſubject were thoſe of Scheffer, one of the members of the Swediſh Academy. They were publiſhed in 1752; and gave this information, that platina is eaſily fuſible with arſenic, but when alone remains unchanged by the moſt violent heat of the furnace. Two years after Dr Lewis publiſhed ſome papers concerning this metal in the Royal Philoſophical Tranſactions of London. This eminent chemiſt, in the courſe of his experiments, had examined it both in the dry and the wet way; diſcovered a number of its relative affinities; mixed it in different proportions with different metals; and had fuſed it with arſenic, though he did not afterwards attempt to ſeparate them.

In 1757 Margraaf publiſhed ſeveral very intereſting obſervations about the method of ſeparating it from the iron which always accompanies it.

In 1758 and 1763 Macquer and Beaumé made upon it a conſiderable number of experiments together, and formed of it at laſt a concave mirror. See *Chemiſtry*, nº 1321.

And it was in 1780 that the *Journaux de Phyſique* gave an account of the labours of Bergman on the ſame ſubject.

The platina of which the toys were made in the Spaniſh Weſt Indies was found by Dr Lewis to be always mixed with ſome other metals. What theſe particular mixtures were is not well known; but many of the allays formed by Dr Lewis himſelf have promiſed to be *Ibid.* nº 1333—1347.

Platina. both ornamental and ufeful. He found that platina, which is $\frac{1}{7}$ of the whole mafs, will render gold no paler than a guinea, which contains only $\frac{1}{12}$ of filver. He found that copper was much improved by allaying it with platina in certain proportions; and that equal parts of platina and brafs formed a compound not fubject to tarnifh, and which might be employed with great advantage for the fpeculums of telefcopes.

Befides allaying it with the different metals, it was an object equally interefting to the chemifts and fociety that platina fhould be obtained pure and unmixed; and that means fhould be contrived to render it fufible, malleable, and ductile. We are now to fee what the chemifts have done to accomplifh thefe ends. They readily faw that it would be neceffary, in the firft place, to bring it to a ftate of ultimate divifion, and that this fhould be tried in one or other of thefe two ways; by diffolving it in acids, or by fufing it along with fome other metal; for by itfelf it had hitherto proved abfolutely unfufible, except when expofed to the focus of a large burning glafs, or the kindled ftream of dephlogifticated or vital air. Among the methods which they employed to feparate it from gold, the principal were the following: The firft was by uniting the mixture of platina and gold with mercury, and grinding the amalgam for a confiderable time with water; in which procefs the platina was gradually thrown out, and the gold retained by the quickfilver. Another method was by mixing a few drops of a folution of platina with above a hundred times the quantity of a folution of gold, and gradually adding a pure fixed alkaline falt as long as it occafioned any effervefcence or precipitation. The remaining liquor in this cafe was fo yellow, that it has been judged the platina would difcover itfelf, though its proportion had been lefs than a thoufandth part of that of gold. A third mode of feparating platina and gold was that of precipitation, by means of mineral fixed alkali; for when this alkali is mixed with a folution of gold containing platina, the gold alone is precipitated, and all the platina remains diffolved. Another method was by precipitation of the platina with fal ammoniac. For this purpofe, to a folution of the metal in aqua regia a fmall quantity of the folution of fal ammoniac in water was added; and if the gold contained any platina, the liquor inftantly grew turbid, and a fine yellow or reddifh precipitate quickly fell to the bottom; if the gold was pure, no precipitation or change of tranfparency enfued. The fifth method of feparation was by means of inflammable liquors. The compound to be examined was diffolved in aqua regia: the folution mingled with twice its quantity or more of rectified fpirit of wine, and the mixture fuffered to ftand for fome days in a glafs flightly covered, the gold rofe to the furface, leaving the platina diffolved. Otherwife, to the folution of the metal in aqua regia about half its quantity of any colourlefs effential oil was added: the two were fhaken well together, and fuffered to reft; upon which the oil rofe immediately to the furface, carrying the gold with it, and leaving the platina diffolved in the acid under it. Or, the gold was taken up ftill more readily and more perfectly by ether, or the etherial fpirit of wine. But, after all, the moft effectual and advantageous method of feparating platina from gold was founded on a property which gold has, and not platina, of being capable of precipitation from aqua regia by martial vitriol; and upon a property which platina has, and not gold, of being capable of precipitation from aqua regia by fal ammoniac. When therefore we would difcover if gold be allayed with platina, let it be diffolved in aqua regia; and to this folution, which will contain both metals, let fome fal ammoniac diffolved in water be added; upon which the platina will be precipitated in form of a brick-coloured fediment. If, on the other fide, we would know if platina contain any gold, let this platina be diffolved in aqua regia, and to the folution add a folution of martial vitriol in water; upon which the liquor will become turbid, and the gold will form a precipitate which may be eafily feparated by decanting and filtrating the liquor. This property which platina poffeffes of being precipitated by martial vitriol was firft difcovered by M. Scheffer.

With refpect to the iron contained among the platina, M. de Buffon feparated, by means of a magnet, fix parts out of feven of a parcel of platina. He diftinguifhed two different matters in platina; of which one was black, friable, and attractable by magnets; and the other confifted of larger grains, was of a livid white or yellowifh colour, much lefs attractable, and was extenfible. Between thefe two different matters were many intermediate particles, fome partaking more of the former, and fome of the latter. He thought that the black matter was chiefly iron; and fays, that he had obferved a fimilar black powder in many ores of iron.

M. Morveau found, that a Pruffian blue could be obtained from the black part of the platina, by pouring upon it fpirit of nitre, and afterwards adding to the folution diluted fome phlogifticated alkali; and that the particles of platina which could not be attracted by magnets, did not by this method fhow any fign of their containing iron.

But the moft important difcovery concerning the feparation of platina from other metals was a method of melting it, by which it became a perfect metal, malleable, and denfer than gold. It was in 1773 and 1774 that M. de Lifle effected this, by diffolving crude platina in aqua regia, precipitating it from the acid menftruum by fal ammoniac, and by fufing this precipitate, without addition, in a double crucible, expofed to the intenfe heat of a forge-fire excited by double bellows. M. Morveau has repeated the experiment, and found that he could melt the precipitate with feveral fluxes; he found likewife that by means of white glafs, borax, and charcoal, he could melt even crude platina, and could allay together platina and fteel in various proportions.

M. de Sickengen was the inventor of another method: he diffolved his platina in aqua regia, and precipitated the iron by the pruffiate of potafs. In evaporating this liquor he obtained fmall octaedral cryftals of the colour of rubies; which, being expofed to a ftrong heat, yielded a metal which bore eafily the ftroke of the hammer, which could be readily drawn into wire, and was extremely malleable.

In attempting to refine platina by the dry way, cupellation was a method to which the chemifts early had recourfe; but, notwithftanding their utmoft endeavours, it has not been attended with all the fuccefs which could have been wifhed. It was found that the fcorification proceeded as well at the beginning of the operation, as when gold and filver are cupelled: but the cupellation

 after-

Platina.

afterwards became more and more difficult; becaufe, as the quantity of lead diminifhed, the matter became lefs and lefs fufible, and at laft ceafed to be fluid, notwithftanding the moft violent heat; and alfo becaufe, when the quantity of platina was greater than that of the lead, this latter metal was protected, and not converted into litharge. Hence the regulus obtained was always dark-coloured, rough, adhering to the cupel, brittle, and weighing more than the platina originally employed, from the lead which remained united with it. Meff. Macquer and Beaumé appear neverthelefs to have carried this experiment further: they kept the matter expofed to a violent fire during a longer time; that is, about 50 hours fucceffively; and therefore, although their platina was tarnifhed and rough on its furface, it was internally white and fhining, eafily feparable from the cupel, and a little diminifhed in weight; a certain proof that no lead remained in it. This platina was alfo ductile, and capable of extenfion under the hammer.

Cupellation, therefore, though not the beft, is at leaft a certain method of applying platina to ufe, and of forming it into utenfils.

What has been thought a preferable method, is firft to fufe the platina with arfenic, and afterwards diffipate this laft metal by a ftrong heat: by this means Achard and Rochon were able to obtain a pure platina; of which the former made fome fmall crucibles, and the latter, by allaying it with copper and tin, fome large mirrors for reflecting telefcopes.

Jeanety of Paris has gone ftill farther: befides fnuff-boxes, watch-chains, and a coffee-pot of platina prepared by this artift, the world has feen a lens weighing fix pounds, a ball weighing nine, and two bars 19 feet long, and weighing no lefs than 11 pounds each. This gentleman has the merit of being the firft who wrought this metal in the great way. The method he employed was far from being new; it had been fuggefted by Scheffer, by Willis, by Margraaf, and was afterwards practifed by Achard, Morveau, and a great many others, but who always prepared it in very fmall quantities. In the Chemical Annals for July 1792, the following account of it is given by himfelf.

The platina is firft pounded in water to difengage it from the ferruginous and other heterogeneous particles that are mixed with it. "This being done, I take (fays he) one pound and a half of platina, two pounds of white arfenic in powder, and one pound of purified potafh. I mix the whole: I put a crucible in the fire capable of containing about 20 pounds; when my furnace and crucible are well heated, I throw into the crucible one third of the mixture, and apply a good heat; I then add a fecond quantity and a third, and fo on, always taking care at every time to mix the whole with a rod of platina. I give now a confiderable force to the fire; and when I am certain that the whole is completely in a ftate of fufion, I withdraw my crucible and leave it to cool. After breaking it, I find a button that is well formed and attractable by the magnet. I bruife this button into fmall pieces, and fufe it a fecond time in the fame manner: if this fecond fufion, which it generally is, be not fufficient to effect the feparation of the iron from the platina, I fufe it a third time; but if I be obliged to do it a third time, I always put two buttons together, to fave at once a crucible and charcoal.

This firft operation being finifhed, I take a crucible with a flat bottom and of a circumference to give to the button about three inches and a quarter in diameter. I make this crucible red hot, and throw into it one pound and a half of the platina which has been already fufed with the arfenic after it was broken into fmall pieces; to this I add a quantity of arfenic of the fame weight, and about half a pound of refined potafh. I give to the fire a confiderable force; and when I am certain that the whole is completely in a ftate of fufion, I withdraw my crucible and leave it to cool, taking care always to place it horizontally, that the button may be of an equal thicknefs. After breaking the crucible, I find a button clear and fonorous, and weighing commonly about 1 pound and 11 ounces. I have remarked, that in proportion to the quantity of arfenic combined with the platina, the purification always fucceeds with the more or lefs promptnefs and eafe; and the greater the proportion fo much the better. In this ftate I put my button into a furnace under a muffle, which ought not to be higher than the edge of the button lying on its flat fide, and inclining a little to the walls of the muffle. In this manner I place three buttons on each fide of the muffle, and apply fire to my furnace, that the muffle may be equally heated throughout: as foon as the buttons begin to evaporate I fhut the doors of my furnace, that the heat may be kept up to the fame degree; this ought always to be carefully attended to even to the end of the operation, for even a temporary excefs of heat might fpoil the whole of my paft operations and render them abortive. I caufe my buttons to volatilize during fix hours, always taking care to change their fituation, that every part may receive an equal portion of heat: I then put them in common oil, and for a like time keep them in a fire fufficient to diffipate the oil in fmoke, I continue this operation as long as the button emits vapours; and when the evaporation has ceafed I pufh the fire as far as it will go by means of the oil. Thefe arfenical vapours have a bright fhining metallic appearance, which I never can obtain any other way, and without which I have never been able to render platina perfectly malleable.

"If thefe fteps which are here pointed out be properly followed, the operation lafts only eight days. My buttons are then thrown into the nitrous acid, and afterwards boiled in diftilled water, till no part of the acid remains with them: I now heap them together one above another, apply the ftrongeft poffible heat, and beat them with a hammer, taking always care at the firft heat to make them red hot in the crucible, that no foreign bodies may mix with them, as before this compreffion they are only fo many fpongy maffes. I afterwards heat them in a naked ftate *(les chauffe à nud)*; and bringing them to a fquare form, I hammer them on all fides for a fhorter or longer time according to their bulk."

Such is the procefs obferved by Jeanety in fufing platina; but he thinks that the working of this metal is fufceptible of ftill greater improvement. In 1788 it was accordingly propofed by fome of the French chemifts to fufe platina by mixing it with charcoal and phofphoric glafs, and afterwards to expofe the phofphure of platina to a heat fufficient to volatilize and diffipate the phofphorus. This method fucceeded remarkably well with M. Pelletier; but, befides being tedious, it is difficult to feparate the laft portions of the phofphorus; and as thefe operations are always coftly, there are few

artists who are willing to undertake them. M. de Morveau has also fused platina with his vitreous flux, made of pounded glass, borax, and charcoal: and Beaumé has advised to fuse it with a slight addition of lead, bismuth, antimony, or arsenic, and by keeping the alloy in the fire a long time to dissipate the metals which have facilitated the fusion. Platina may likewise be fused with a metal soluble in an acid; the mixture being pulverized, the alloyed metal may be dissolved, and the powder of platina may then be fused with the flux of De Morveau; or, instead of using a soluble metal, a calcinable metal may be employed, and heated as before †.

† *Chaptal.*

The colour of platina, when properly refined, is something between that of iron and silver; it has no smell, and is the heaviest body yet known in nature. According to Mr Kirwan its specific gravity is to that of water as 23 to 1. It may likewise be said to be the most durable of all the metals: it is harder than iron; it undergoes no alteration in the air, and fire alone does not even appear to possess the power of changing it; for which reason it forms the best of all crucibles that have yet been invented. It resists the action of acids, alkalis, and sulphurs: it may be rolled into plates as fine as leaves of gold which are used in gilding; it is likewise extremely ductile: and Dr Withering tells us, that a wire of platina is stronger than a wire of gold or of silver of the same thickness; it is preferable to gold by the property which it has of soldering or welding without mixture; and it unites, says Chaptal, two qualities never before found in one and the same substance. When formed into a mirror, it reflects but one image, at the same time that it is as unchangeable as a mirror of glass.

As those motives which at first prepossessed the court of Spain against this metal no longer exist, it is to be hoped that the decree which was passed against it will soon be revoked, and that the Spanish monarch will neither despise so rich a treasure as his mines of platina, nor refuse to the world the numerous advantages that may be derived from a substance that promises to be of so much importance in commerce and the arts.

PLATING is the art of covering baser metals with a thin plate of silver either for use or for ornament. It is said to have been invented by a spur-maker, not for show but for real utility. Till then the more elegant spurs in common use were made of solid silver, and from the flexibility of that metal they were liable to be bent into inconvenient forms by the slightest accident. To remedy this defect, a workman at Birmingham contrived to make the branches of a pair of spurs hollow, and to fill that hollow with a slender rod of steel or iron. Finding this a great improvement, and being desirous to add cheapness to utility, he continued to make the hollow larger, and of course the iron thicker and thicker, till at last he discovered the means of coating an iron spur with silver in such a manner as to make it equally elegant with those which were made wholly of that metal. The invention was quickly applied to other purposes; and to numberless utensils which were formerly made of brass or iron are now given the strength of these metals, and the elegance of silver, for a small additional expence.

The silver plate is generally made to adhere to the baser metal by means of solder; which is of two kinds, the *soft* and the *hard*, or the *tin* and *silver* solders. The former of these consists of tin alone, the latter generally of three parts of silver and one of brass. When a buckle, for instance, is to be plated by means of the soft solder, the ring, before it is bent, is first tinned, and then the silver-plate is gently hammered upon it, the hammer employed being always covered with a piece of cloth. The silver now forms, as it were, a mould to the ring, and whatever of it is not intended to be used is cut off. This mould is fastened to the ring of the buckle by two or three cramps of small iron-wire; after which the buckle, with the plated side undermost, is laid upon a plate of iron sufficiently hot to melt the tin, but not the silver. The buckle is then covered with powdered resin or anointed with turpentine; and lest there should be a deficiency of tin, a small portion of rolled tin is likewise melted on it. The buckle is now taken off with a tongs, and commonly laid on a bed of sand, where the plate and the ring, while the solder is yet in a state of fusion, are more closely compressed by a smart stroke with a block of wood. The buckle is afterwards bent and finished.

Sometimes the melted tin is poured into the silver mould, which has been previously rubbed over with some flux. The buckle ring is then put among the melted tin, and the plating finished. This is called by the workmen *filling up*.

When the hard solder is employed, the process is in many respects different. Before the plate is fitted to the iron or other metal, it is rubbed over with a solution of borax. Stripes of silver are placed along the joinings of the plate; and instead of two or three cramps, as in the former case, the whole is wrapped round with small wire; the solder and joinings are again rubbed with the borax, and the whole put into a charcoal fire till the solder be in fusion. When taken out the wire is instantly removed, the plate is cleaned by the application of some acid, and afterwards made smooth by the strokes of a hammer.

Metal plating is when a bar of silver and copper are taken of at least one equal side. The equal sides are made smooth, and the two bars fastened together by wire wrapped round them. These bars are then sweated in a charcoal fire; and after sweating, they adhere as closely together as if they were soldered. After this they are flattened into a plate between two rollers, when the copper appears on one side and the silver on the other. This sort of plate is named *plated metal*.

French plating is when silver-leaf is burnished on a piece of metal in a certain degree of heat.

When silver is dissolved in aquafortis, and precipitated upon another metal, the process is called *silvering*. See SOLDERING.

PLATO, an illustrious philosopher of antiquity, was by descent an Athenian, though the place of his birth was the Island of Egina. His lineage through his father is traced back to Codrus the last king of Athens and through his mother to Solon the celebrated legislator. The time of his birth is commonly placed in the beginning of the 88th Olympiad; but Dr Enfield thinks it may be more accurately fixed in the third year of the 87th Olympiad, or 430 years before the Christian era. He gave early indications of an extensive and original genius, and had an education suitable to his high rank, being instructed in the rudiments of letters by the grammarian Dionysius, and trained in athletic exercises by

Plato. Arifto of Argos. He applied with great diligence to the ftudy of the arts of painting and poetry; and made fuch proficiency in the latter, as to produce an epic poem, which, upon comparing it with the poems of Homer, he committed to the flames. At the age of 20 he compofed a dramatic piece; but after he had given it to the performers, happening to attend upon a difcourfe of Socrates, he was fo captivated by his eloquence, that he reclaimed his tragedy without fuffering it to be acted, renounced the mufes, burnt all his poems, and applied himfelf wholly to the ftudy of wifdom.

It is thought that Plato's firft mafters in philofophy were Cratylus and Hermogenes, who taught the fyftems of Heraclitus and Parmenides; but when he was 20 years old, he attached himfelf wholly to Socrates, with whom he remained eight years in the relation of a fcholar. During this period, he frequently difpleafed his companions, and fometimes even his mafter, by grafting upon the Socratic fyftem opinions which were taken from fome other ftock. It was the practice of the fcholars of Socrates to commit to writing the fubftance of their mafter's difcourfes. Plato wrote them in the form of dialogues; but with fo great additions of his own, that Socrates, hearing him recite his Lyfis, cried out, "O Hercules! how many things does this young man feign of me!"

Plato, however, retained the warmeft attachment to his mafter. When that great and good man was fummoned before the fenate, his illuftrious fcholar undertook to plead his caufe, and begun a fpeech in his defence; but the partiality and violence of the judges would not permit him to proceed. After the condemnation, he prefented his mafter with money fufficient to redeem his life; which, however, Socrates refufed to accept. During his imprifonment, Plato attended him, and was prefent at a converfation which he held with his friends concerning the immortality of the foul; the fubftance of which he afterwards committed to writing in the beautiful dialogue intitled *Phædo*, not, however, without interweaving his own opinions and language.

The philofophers who were at Athens were fo alarmed at the death of Socrates, that moft of them fled from the city to avoid the injuftice and cruelty of the government. Plato, whofe grief upon this occafion is faid by Plutarch to have been exceffive, retired to Megara; where he was friendly entertained by Euclid, who had been one of Socrates's firft fcholars, till the ftorm was over. Afterwards he determined to travel in purfuit of knowledge; and from Megara he went to Italy, where he conferred with Eurytus, Philolaus, and Archytas. Thefe were the moft celebrated of the followers of Pythagoras, whofe doctrine was then become famous in Greece; and from thefe the Pythagoreans have affirmed that he had all his natural philofophy. He dived into the moft profound and myfterious fecrets of the Pythagoric doctrines; and perceiving other knowledge to be connected with them, he went to Cyrene, where he learned geometry of Theodorus the mathematician. From thence he paffed into Egypt, to acquaint himfelf with the theology of their priefts, to ftudy more nicely the proportions of geometry, and to inftruct himfelf in aftronomical obfervations; and having taken a full furvey of all the country, he fettled for fome time in the province of Sais, learning of the wife men there, what they held concerning the univerfe, whether it had a beginning, whether it moved wholly or in part, &c.; and Paufanias affirms, that he learned from thefe the immortality, and alfo the tranfmigration, of fouls. Some of the fathers will have it, that he had communication with the books of Mofes, and that he ftudied under a learned Jew of Heliopolis; but there is nothing that can be called evidence for thefe affertions. St Auftin once believed that Plato had fome conference with Jeremiah; but afterwards difcovered, that that prophet muft have been dead at leaft 60 years before Plato's voyage to Egypt.

Plato's curiofity was not yet fatisfied. He travelled into Perfia to confult the magi about the religion of that country: and he defigned to have penetrated even to the Indies, and to have learned of the Brachmans their manners and cuftoms; but the wars in Afia hindered him.

"He then returned into Italy, to the Pythagorean fchool at Tarentum, where he endeavoured to improve his own fyftem, by incorporating with it the doctrine of Pythagoras, as it was then taught by Archytas, Timæus, and others. And afterwards, when he vifited Sicily, he retained fuch an attachment to the Italic fchool, that, through the bounty of Dionyfius, he purchafed at a vaft price feveral books which contained the doctrine of Pythagoras, from Philolaus, one of his followers.

"Returning home richly ftored with knowledge of various kinds, Plato fettled in Athens, and executed the defign, which he had doubtlefs long had in contemplation, of forming a new fchool for the inftruction of youth in the principles of philofophy. The place which he made choice of for this purpofe was a public grove, called the *Academy*, from Hecademus, who left it to the citizens for the purpofe of gymnaftic exercifes. Adorned with ftatues, temples, and fepulchres, planted with lofty plane-trees, and interfected by a gentle ftream, it afforded a delightful retreat for philofophy and the mufes. Of this retreat Horace fpeaks:

Atque inter fylvas Academi quærere verum,

"'Midft Academic groves to fearch for truth."

Within this inclofure he poffeffed, as a part of his humble patrimony, purchafed at the price of three thoufand drachmas, a fmall garden, in which he opened a fchool for the reception of thofe who might be inclined to attend his inftructions. How much Plato valued mathematical ftudies, and how neceffary a preparation he thought them for higher fpeculations, appears from the infcription which he placed over the door of his fchool: Ουδεις αγεωμετρητος εισιτω. "Let no one who is unacquainted with geometry enter here."

"This new fchool foon became famous, and its mafter was ranked among the moft eminent philofophers. His travels into diftant countries, where learning and wifdom flourifhed, gave him celebrity among his brethren of the Socratic fect. None of thefe had ventured to inftitute a fchool in Athens except Ariftippus; and he had confined his inftructions almoft entirely to ethical fubjects, and had brought himfelf into fome difcredit by the freedom of his manners. Plato alone remained to inherit the patrimony of public efteem which Socrates had left his difciples; and he poffeffed talents and learning adequate to his defign of extending the ftudy of philofophy beyond the limits within which it had been inclofed

Plato.

closed by his master. The consequence was, not only that young men crowded to his school from every quarter, but that people of the first distinction in every department frequented the academy. Even females, disguised in mens clothes, often attended his lectures. Among the illustrious names which appear in the catalogue of his followers are Dion the Syracusan prince, and the orators Hyperides, Lycurgus, Demosthenes, and Isocrates.

"Greatness was never yet exempted from envy. The distinguished reputation of Plato brought upon him the hatred of his former companions in the school of Socrates, and they loaded him with detraction and obloquy. It can only be ascribed to mutual jealousy, that Xenophon and he, though they relate the discourses of their common master, studiously avoid mentioning one another. Diogenes the Cynic ridiculed Plato's doctrine of ideas and other abstract speculations. In the midst of these private censures, however, the public fame of Plato daily increased; and several states, among which were the Arcadians and Thebans, sent ambassadors with earnest requests that he would come over, not only to instruct the young men in philosophy, but also to prescribe them laws of government. The Cyrenians, Syracusians, Cretans, and Eleans, sent also to him: he did not go to any of them, but gave laws and rules of governing to all. He lived single, yet soberly and chastly. He was a man of great virtues, and exceedingly affable; of which we need no greater proof, than his civil manner of conversing with the philosophers of his own times, when pride and envy were at their height. His behaviour to Diogenes is always mentioned in his history. The Cynic was vastly offended, it seems, at the politeness and fine taste of Plato, and used to catch all opportunities of snarling at him. He dined one day at his table with other company, and, trampling upon the tapestry with his dirty feet, uttered this brutish sarcasm, "I trample upon the pride of Plato;" to which Plato wisely reparteed, "With greater pride."

The fame of Plato drew disciples to him from all parts; among whom were Speusippus an Athenian, his sister's son, whom he appointed his successor in the academy, and the great Aristotle.

The admiration of this illustrious man was not confined to the breasts of a few philosophers. He was in high esteem with several princes, particularly Archelaus king of Macedon, and Dionysius tyrant of Sicily. At three different periods he visited the court of this latter prince, and made several bold but unsuccessful attempts to subdue his haughty and tyrannical spirit. A brief relation of the particulars of these visits to Sicily may serve to cast some light upon the character of our philosopher; and we shall give it in the words of Dr Enfield, from whose elegant history of philosophy we have extracted by much the most valuable parts of this article.

"The professed object of Plato's first visit to Sicily, which happened in the 40th year of his age, during the reign of the elder Dionysius the son of Hermocrates, was, to take a survey of the island, and particularly to observe the wonders of Mount Ætna. Whilst he was resident at Syracuse, he was employed in the instruction of Dion, the king's brother-in-law, who possessed excellent abilities, though hitherto restrained by the terrors of a tyrannical government, and relaxed by the luxuries of a licentious court. Disgusted by the debauched manners of the Syracusans, he endeavoured to rescue his pupil from the general depravity. Nor did Dion disappoint his preceptor's expectations. No sooner had he received a taste of that philosophy which leads to virtue, than he was fired with an ardent love of wisdom. Entertaining an hope that philosophy might produce the same effect upon Dionysius, he took great pains to procure an interview between Plato and the tyrant. In the course of the conference, whilst Plato was discoursing on the security and happiness of virtue, and the miseries attending injustice and oppression, Dionysius, perceiving that the philosopher's discourse was levelled against the vices and cruelties of his reign, dismissed him with high displeasure from his presence, and conceived a design against his life. It was not without great difficulty that Plato, by the assistance of Dion, made his escape. A vessel which had brought over Pollis, a delegate from Sparta, was fortunately at that time returning to Greece. Dion engaged Pollis to take the charge of the philosopher, and land him safely in his native country; but Dionysius discovered the design, and obtained a promise from Pollis, that he would either put him to death or sell him as a slave upon the passage. Pollis accordingly sold him in the island of Ægina; the inhabitants of which were then at war with the Athenians. Plato could not long remain unnoticed: Anicerris, a Cyrenaic philosopher, who happened to be at that time in the island, discovered the stranger, and thought himself happy in an opportunity of showing his respect for so illustrious a philosopher: he purchased his freedom for 30 minæ, or 84l. 10s. Sterling money, and sent him home to Athens. Repayment being afterwards offered to Anicerris by Plato's relations, he refused the money, saying, with that generous spirit which true philosophy always inspires, that he saw no reason why the relations of Plato should engross to themselves the honour of serving him."

After a short interval, Dionysius repented of his ill-placed resentment, and wrote to Plato, earnestly requesting him to repair his credit by returning to Syracuse; to which Plato gave this high-spirited answer, that philosophy would not allow him leisure to think of Dionysius. He was, however, prevailed upon by his friend Dion to accept of the tyrant's invitation to return to Syracuse, and take upon him the education of Dionysiu the younger, who was heir apparent to the monarchy. He was received by Dionysius the reigning sovereign with every possible appearance of respect; but after seeing his friend banished, and being himself kept as a prisoner at large in the palace, he was by the tyrant sent back into his own country, with a promise that both he and Dion should be recalled at the end of the war in which the Sicilians were then engaged. This promise was not fulfilled. The tyrant wished for the return of Plato; but could not resolve to recal Dion. At last, however, having probably promised that the philosopher should meet his friend at the court of Syracuse, he prevailed upon Plato to visit that capital a third time. When he arrived, the king met him in a magnificent chariot, and conducted him to his palace. The Sicilians too rejoiced in his return; for they hoped that the wisdom of Plato would at length triumph over the tyrannical spirit of the prince. Dionysius seemed wholly divested of his former resentments, listened with apparent pleasure to the philosopher's doctrine, and, among other expressions of regard, presented him with eighty talents

of

Plato. of gold. In the midst of a numerous train of philosophers, Plato now possessed the chief influence and authority in the court of Syracuse. Whilst Aristippus was enjoying himself in splendid luxury; whilst Diogenes was freely indulging his acrimonious humour; and whilst Æschines was gratifying his thirst after riches;—Plato supported the credit of philosophy with an air of dignity, which his friends regarded as an indication of superior wisdom, but which his enemies imputed to pride. After all, it was not in the power of Plato to prevail upon Dionysius to adopt his system of policy, or to recal Dion from his exile. Mutual distrust, after a short interval, arose between the tyrant and the philosopher; each suspected the other of evil designs, and each endeavoured to conceal his suspicion under the disguise of respect. Dionysius attempted to impose upon Plato by condescending attentions, and Plato to deceive Dionysius by an appearance of confidence. At length, the philosopher became so much dissatisfied with his situation, that he earnestly requested permission to return to Greece, which was at last granted him, and he was sent home loaded with rich presents. On his way to Athens, passing through Elis during the celebration of the Olympic games, he was present at this general assembly of the Greeks, and engaged universal attention.

From this narrative it appears, that if Plato visited the courts of princes, it was chiefly from the hope of seeing his ideal plan of a republic realized; and that his talents and attainments rather qualified him to shine in the academy than in the council or the senate.

Plato, now restored to his country and his school, devoted himself to science, and spent the last years of a long life in the instruction of youth. Having enjoyed the advantage of an athletic constitution, and lived all his days temperately, he arrived at the 81st, or according to some writers the 79th, year of his age, and died, through the mere decay of nature, in the first year of the hundred and eighth Olympiad. He passed his whole life in a state of celibacy, and therefore left no natural heirs, but transferred his effects by will to his friend Adiamantus. The grove and garden, which had been the scene of his philosophical labours, at last afforded him a sepulchre. Statues and altars were erected to his memory; the day of his birth long continued to be celebrated as a festival by his followers; and his portrait is to this day preserved in gems: but the most lasting monuments of his genius are his writings, which have been transmitted, without material injury, to the present times.

The character of this philosopher has always been high. Besides the advantages of a noble birth, he had a large and comprehensive understanding, a vast fund of wit and good taste, great evenness and sweetness of temper, all cultivated and refined by education and travel; so that it is no wonder if he was honoured by his countrymen, esteemed by strangers, and adored by his scholars. The ancients thought more highly of Plato than of all their philosophers: they always called him the *Divine Plato*; and they seemed resolved that his descent should be more than human. "There are (says Apuleius) who assert Plato to have sprung from a more sublime conception; and that his mother Perictione, who was a very beautiful woman, was impregnated by Apollo in the shape of a spectre." Plutarch, Suidas, and others, affirm this to have been the common report at Athens. When he was an infant, his father Aristo went to Hymettus, with his wife and child, to sacrifice to the muses; and while they were busied in the divine rites, a swarm of bees came and distilled their honey upon his lips. This, says Tully, was considered as a presage of his future eloquence. Apuleius relates, that Socrates, the night before Plato was recommended to him, dreamed that a young swan fled from Cupid's altar in the academy, and settled in his lap; thence soared to heaven, and delighted the gods with its music: and when Aristo the next day presented Plato to him, "Friends (says Socrates), this is the swan of Cupid's academy." The Greeks loved fables: they show however in the present case, what exceeding respect was paid to the memory of Plato. Tully perfectly adored him; tells us, how he was justly called by Panætius the *divine*, the *most wise*, the *most sacred*, the *Homer of philosophers*; intitled him to Atticus, *Deus ille noster*; thinks, that if Jupiter had spoken Greek, he would have spoken in Plato's language; and made him so implicitly his guide in wisdom and philosophy, as to declare, that he had rather err with Plato than be right with any one else. But, panegyric aside, Plato was certainly a very wonderful man, of a large and comprehensive mind, an imagination infinitely fertile, and of a most flowing and copious eloquence. Nevertheless, the strength and heat of fancy prevailing in his composition over judgment, he was too apt to soar beyond the limits of earthly things, to range in the imaginary regions of general and abstracted ideas; and on which account, though there is always a greatness and sublimity in his manner, he did not philosophize so much according to truth and nature as Aristotle, though Cicero did not scruple to give him the preference.

The writings of Plato are all in the way of dialogue; where he seems to deliver nothing from himself, but every thing as the sentiments and opinions of others, of Socrates chiefly, of Timæus, &c. He does not mention himself anywhere, except once in his Phædo, and another time in his Apology for Socrates. His style, as Aristotle observed, is betwixt prose and verse: on which account, some have not scrupled to rank him with the poets. There is a better reason for so doing than the elevation and grandeur of his style: his matter is oftentimes the offspring of imagination, instead of doctrines or truths deduced from nature. The first edition of Plato's works in Greek was put out by Aldus at Venice in 1513; but a Latin version of him by Marsilius Ficinus had been printed there in 1491. They were reprinted together at Lyons in 1588, and at Francfort in 1602. The famous printer Henry Stephens, in 1578, gave a most beautiful and correct edition of Plato's works at Paris, with a new Latin version by Serranus, in three volumes folio; and this deservedly passes for the best edition of Plato: yet Serranus's version is very exceptionable, and in many respects, if not in all, inferior to that of Ficinus.

PLATONIC, something that relates to Plato, his school-philosophy, opinions, or the like. Thus, platonic love denotes a pure spiritual affection, for which Plato was a great advocate, subsisting between the different sexes, abstracted from all carnal appetites, and regarding no other object but the mind and its beauties;

Platonic, Platoniſm.

or it is even a ſincere diſintereſted friendſhip ſubſiſting between perſons of the ſame ſex, abſtracted from any ſelfiſh views, and regarding no other object than the perſon, if any ſuch love or friendſhip has aught of a foundation in nature.

Platonic Year, or the *Great Year*, is a period of time determined by the revolution of the equinoxes, or the ſpace wherein the ſtars and conſtellations return to their former places, in reſpect of the equinoxes. The platonic year, according to Tycho Brahe, is 25816, according to Ricciolus 25920, and according to Caſſini 24800 years.

This period once accompliſhed, it was an opinion among the ancients that the world was to begin anew, and the ſame ſeries of things to turn over again.

PLATONISM, the philoſophy of Plato, which was divided into three branches, *theology*, *phyſics*, and *mathematics*. Under *theology* was comprehended metaphyſics and ethics, or that which in modern language is called *moral* philoſophy. Plato wrote likewiſe on *dialectics*, but with ſuch inferiority to his pupil Ariſtotle, that his works in that department of ſcience are ſeldom mentioned.

The ancient philoſophers always began their theological ſyſtems with ſome diſquiſition on the nature of the gods, and the formation of the world; and it was a fundamental doctrine with them, that *from nothing nothing can proceed*. We are not to ſuppoſe that this general axiom implied nothing more than that for every effect there muſt be a cauſe; for this is a propoſition which no man will controvert who underſtands the terms in which it is expreſſed: but the ancients believed that a proper creation is impoſſible even to Omnipotence, and that to the production of any thing a *material* is not leſs *neceſſary* than an *efficient* cauſe, (ſee Metaphysics, n°264, 304.) That with reſpect to this important queſtion, Plato agreed with his predeceſſors and contemporaries, appears evident to us from the whole tenor of his *Timæus*. We agree with Dr Enfield § in thinking, that in this dialogue, which comprehends his whole doctrine on the ſubject of the formation of the univerſe, matter is ſo manifeſtly ſpoken of as eternally co-exiſting with God, that this part of his doctrine could not have been miſtaken by ſo many learned and able writers, had they not been ſeduced by the deſire of eſtabliſhing a coincidence of doctrine between the writings of Plato and Moſes. It is certain that neither Cicero ‡, nor Apuleius ‖, nor Alcinous †, nor even the later commentator Chalcidius, underſtood their maſter in any other ſenſe than as admitting two primary and incorruptible principles, God and matter; to which we ſhall afterwards ſee reaſon to add a third, namely ideas. The paſſages quoted by thoſe who maintain the contrary opinion are by no means ſufficient for their purpoſe. Plato, it is true, in his Timæus, calls God the *parent of the univerſe*, and in his Sophiſta ſpeaks of him as "forming animate and inanimate beings, which did not before exiſt:" but theſe expreſſions do not neceſſarily imply that this offſpring of Deity was produced from nothing, or that no prior matter exiſted from which theſe new beings were formed. Through the whole dialogue of the Timæus, Plato ſuppoſes two eternal and independent cauſes of all things; one, that by which all things are made, which is God; the other, that from which all things are made, which is matter. He diſtinguiſhes between God, matter, and the univerſe, and ſuppoſes the Architect of the world to have formed it out of a maſs of pre-exiſtent matter. Matter, according to Plato, is an eternal and infinite principle. His doctrine on this head is thus explained by Cicero ‡. "Matter, from which all things are produced and formed, is a ſubſtance without form or quality, but capable of receiving all forms, and undergoing every kind of change; in which, however, it never ſuffers annihilation, but merely a ſolution of its parts, which are in their nature infinitely diviſible, and move in portions of ſpace which are alſo infinitely diviſible. When that principle which we call quality is moved, and acts upon matter, it undergoes an entire change, and thoſe forms are produced, from which ariſes the diverſified and coherent ſyſtem of the univerſe." This doctrine Plato unfolds at large in his Timæus, and particularly inſiſts upon the notion, that matter has originally no form, but is capable of receiving any. He calls it the mother and receptacle of forms, by the union of which with matter the univerſe becomes perceptible to the ſenſes; and maintains, that the viſible world owes its forms to the energy of the divine intellectual nature.

§ Hiſt. of Phil.

‡ Ac. Qu. c. 6. ‖ Lib. I. † c. 12.

‡ Ac. Qu. l. i. c. 8.

Our author is ſupported in drawing this inference by the teſtimony of Diogenes Laertius, who ſurely underſtood the language and dogmas of Plato better than the moſt accompliſhed modern ſcholar can pretend to do; yet a learned writer ‡ has lately expreſſed great ſurpriſe that any one ſhould conſider matter as having been, in Plato's opinion, uncreated; and he boldly affirms, that Laertius, inſtead of aſſerting that ſpirit and matter were the principles of all things, ought to have ſaid that God alone, in Plato's eſtimation, was their original.—To prove this, he gives from the Timæus a quotation, in which the founder of the Academy declares that God *framed* heaven and earth, and the inferior deities; and that as he *faſhioned*, ſo he pervades all nature. He obſerves, that Cicero denominates the god of Plato the *maker*, and the god of Ariſtotle only the *governor*, of the world. And, to ſatiſfy thoſe who may demand a particular proof of Plato's having taught a real creation, he affirms that his writings abound with declarations on the ſubject, of which the meaning cannot be miſapprehended. "With this purpoſe (ſays he) Plato denominates at one time the principles or ſubſtance of all things, Γενοματα θεου Δημιουργου, the productions of the efficient Deity, and at others enters more particularly into the queſtion. Thus, he obſerves, that many perſons are ignorant of the nature and power of mind or intellect, 'as having exiſted at the beginning, antecedent to all bodies.' Of this mind, he obſerves, that it is without exception Παντων πρεσβυτατη, *of all things the moſt ancient*; and he ſubjoins, in order to remove all doubt of his purpoſe, that it is alſo Αρχη κινησεως, *the cauſe or principle of motion*."

‡ Dr Ogilvie.

Theology of Plato.

With all poſſible reſpect for Dr Ogilvie, of whoſe piety and erudition we are thoroughly convinced, we muſt take the liberty to ſay, that to us the declarations of Plato on this ſubject appear much leſs preciſe and explicit than they appear to him; and that the inference which he would draw from the *words* of Cicero ſeems not to flow neceſſarily from the *ſenſe* of thoſe words. That Plato believed God to have *framed* the heaven and the earth, and to have *faſhioned* all nature, is a poſition which, as far as we know, has never been controverted; but between *framing* or *faſhioning* the chaos or ὑλη πρωτη, and calling the univerſe into exiſtence from non-

Platonism.

entity, there is an infinite and an obvious difference. The diſtinction made by Cicero between the God of Plato and the God of Ariſtotle is a juſt diſtinction, but it will not bear the ſuperſtructure which the learned Doctor builds upon it. Ariſtotle maintained the eternity of the world in its preſent form. Plato certainly taught that the firſt matter was in time reduced from a chaotic ſtate into *form* by the power of the Demiurgus; but we have ſeen nothing in his writings which explicitly declares his belief that the *firſt matter* was itſelf *created*.

The learned Cudworth, who wiſhed, like Dr Ogilvie, to find a coincidence of doctrine between the theology of Plato and that of the Goſpel, ſtrained all his faculties to prove that his favourite philoſopher taught a proper creation; but he laboured in vain. He gives a number of quotations in ſupport of his poſition; of which we ſhall here inſert only thoſe two upon which Dr Ogilvie ſeems to lay the greateſt ſtreſs. Plato, ſays the author of the Intellectual Syſtem, calls the one God (A) ὃς γην ουρανον και θεους, και παντα τα εν ουρανω και τα εν ἅδου, και ὑπο γης ἁπαντα εργαζεται—*He that makes earth, and heaven, and the gods, and doth all things both in heaven, and hell, and under the earth.* And, again, "he by whoſe efficiency the things of the world (ὕστερον εγενετο, προτερον ουκ οντα) *were afterwards made when they were not before**." Both Cudworth and Ogilvie think this laſt ſentence an explicit declaration of Plato's belief in the creative power of God: but that they are miſtaken has been evinced by Moſheim with a force of argument which will admit of no reply. In that part of *the Sophiſt* from which the quotation is taken, Plato conſiders the δυναμιν ποιητικην, of which he is treating, as belonging both to God and to man; and he defines it in general to be "a certain power which is the cauſe that things may afterwards be which were not before." Cudworth wiſhes to confine this definition to the divine power; and adds from himſelf to the text which he quotes the following words, which are not in Plato, OR FROM AN ANTECEDENT NON-EXISTENCE BROUGHT FORTH INTO BEING! That the incomparable author intended to deceive his reader, we are far from imagining: his zeal for Platoniſm had deceived himſelf. Plato's definition comprehends the δυναμιν ποιητικην † as well of man as of God; and therefore cannot infer a creative power anywhere, unleſs the father of the academy was ſo very abſurd as to ſuppoſe human artiſts the creators of thoſe machines which they have invented and made! Moſheim thinks that Cudworth was miſled by too implicit a confidence in *Ficinus*; and it is not impoſſible that Dr Ogilvie may have been ſwayed by the authority, great indeed, of the author of the Intellectual Syſtem.

* *Sophiſta*, p. 168.

† *Moſch. ed Cud. Syſt. Intel.* cap. 4. § 23. n. 11.

That intellect exiſted antecedent to all bodies is indeed a Platonic dogma, from which Dr Ogilvie, after Cudworth, wiſhes to infer that the doctrine of the creation was taught in the academy; but Dr Ogilvie knows, and no man knew better than Cudworth, that Plato, with every other Greek philoſopher, diſtinguiſhed between *body* and *matter*; and that though he held the priority of intellect to the former, it by no means follows that he believed it to have exiſted antecedent to the latter. That he believed *mind*, or rather *ſoul* (for he diſtinguiſhes between the two), to be the cauſe or principle of motion, cannot be denied; but we are not therefore authoriſed to conclude that he likewiſe believed it to be the cauſe of the exiſtence of matter. That he believed mind to be the moſt ancient of *all things*, taking the word *things* in the moſt abſolute ſenſe, cannot be true, ſince by Dr Ogilvie's own acknowledgment he held the exiſtence and eternity of *ideas*, not to add that he believed το ἓν or τ᾽αγαθον—the firſt hypoſtaſis in his trinity, to be ſuperior to mind and prior to it, though not in time, yet in the order of nature. When therefore he calls mind the moſt ancient of *all things*, he muſt be ſuppoſed to mean only that it is more ancient than *all bodies* and inferior ſouls. It is no reflection on the character of Plato that he could not, by the efforts of his own reaſon, acquire any notion of a proper creation; ſince we, who have the advantage of his writings, and of writings infinitely more valuable, to inſtruct us, find it extremely difficult, if not impoſſible, to conceive how any thing can begin to be. We believe the fact on the authority of revelation; but ſhould certainly have never agitated ſuch a queſtion, had it not been ſtated to us by writers inſpired with celeſtial wiſdom.

In the Platonic coſmogony we cannot therefore doubt but that the eternity of the ὕλη πρωτη was taken for granted. Whether it was an eternal and neceſſary emanation from an eternal mind, is not perhaps quite ſo evident, though our own opinion is, that it was believed to be ſelf-exiſtent. But be this as it may, which is not worth diſputing, one thing is certain, that Plato did not believe it to have a ſingle form or quality which it did not receive either from the *Demiurgus* or the *Pſyche*—the ſecond or third perſon of his trinity. Except Ariſtotle, all the Greek philoſophers, who were not materialiſts, held nearly the ſame opinions reſpecting the origin of the world; ſo that in examining their ſyſtems we ſhall be greatly miſled if we underſtand the terms *incorporeal* and *immaterial* as at all ſynonymous. It was alſo a doctrine of Plato, that there is in matter a neceſſary but blind and refractory force; and that hence ariſes a propenſity in matter to diſorder and deformity, which is the cauſe of all the imperfection which appears in the works of God, and the origin of evil. On this ſubject Plato writes with wonderful obſcurity: but, as far as we are able to trace his conceptions, he appears to have thought, that matter, from its nature, reſiſts the will of the Supreme Artificer, ſo that he cannot perfectly execute his deſigns; and that this is the cauſe of the

(A) Moſheim affirms that this quotation is nowhere to be found in the writings of Plato. He therefore at firſt ſuſpected that the learned author, in looking haſtily over Plato's 10th book *De Legibus*, had transferred to God what is there ſaid of the *anima mundi*, leading by its own motions every thing in the heaven, the earth, and the ſea, and that he had added ſomething of his own. He dropped that opinion, however, when he found Plato, in the 10th book of his Republic, declaring it to be as "eaſy for God to produce the ſun, moon, ſtars, and earth, &c. from himſelf, as it is for us to produce the image of ourſelves, and whatever elſe we pleaſe, only by interpoſing a looking-glaſs." In all this power, however, there is nothing ſimilar to that of creation.

...ism the mixture of good and evil which is found in the material world.

Plato, however, was no materialist. He taught, that there is an intelligent cause, which is the origin of all spiritual being, and the former of the material world. The nature of this great being he pronounced it difficult to discover, and when discovered impossible to divulge. The existence of God he inferred from the marks of intelligence, which appear in the form and arrangement of bodies in the visible world: and from the unity of the material system he concluded, that the mind by which it was formed must be one. God, according to Plato, is the supreme intelligence, incorporeal, without beginning, end, or change, and capable of being perceived only by the mind. He certainly distinguished the Deity not only from body, and whatever has corporeal qualities, but from matter itself, from which all things are made. He also ascribed to him all those qualities which modern philosophers ascribe to immaterial substance; and conceived him to be in his nature simple, uncircumscribed in space, the author of all regulated motion, and, in fine, possessed of intelligence in the highest perfection.

His notions of God are indeed exceedingly refined, and such as it is difficult to suppose that he could ever have acquired but from some obscure remains of primeval tradition, gleaned perhaps from the priests of Egypt or from the philosophers of the East. In the Divine Nature he certainly believed that there are two, and probably that there are three, *hypostases*, whom he called το ον and το έν, νους and ψυχη. The first he considered as self-existent, and elevated far above all mind and all knowledge; calling him, by way of eminence, *the being*, or *the one*. The only attribute which he acknowledged in this person was goodness; and therefore he frequently styles him το αγαθον—*the good*, or *essential goodness*. The second he considered as mind, the *wisdom* or *reason* of the first, and the *maker of the world*; and therefore he styles him νους, λογος, and δημιουργος. The third he always speaks of as the *soul of the world*; and hence calls him ψυχη, or ψυχη του κοσμου. He taught that the *second* is a necessary emanation from the *first*, and the *third* from the *second*, or perhaps from the *first* and *second*.

Some have indeed pretended, that the *Trinity*, which is commonly called *Platonic*, was a fiction of the later Platonists, unknown to the founder of the school: but any person who shall take the trouble to study the writings of Plato, will find abundant evidence that he really asserted a triad of divine hypostases, all concerned in the formation and government of the world. Thus in his 10th book of Laws, where he undertakes to prove the existence of a Deity in opposition to atheists, he ascends no higher in the demonstration than to the ψυχη or mundane soul, which he held to be the immediate and proper cause of all the motion that is in the world. But in other parts of his writings he frequently asserts, as superior to the self-moving principle, an immoveable νους or intellect, which was properly the *demiurgus* or framer of the world; and above this *hypostasis* one most simple and absolutely perfect being, who is considered in his *Theology* as αυτοθεος, the *original deity*, in contradistinction from the others, who are only θεοι εκ θεου. These doctrines are to be gathered from his works at large, particularly from the *Timæus*, *Philebus*, *Sophista*, and *Epinomis*: but there is a passage in his second epistle to Dionysius, apparently written in answer to a letter in which that monarch had required him to give a more explicit account than he had formerly done of the nature of God, in which the doctrine of a Trinity seems to be directly asserted. "After having said that he meant to wrap up his meaning in such obscurity, as that an adept only should fully comprehend it, he adds expressions to the following import: 'The Lord of Nature is surrounded on all sides by his works: whatever is, exists by his permission: he is the fountain and source of excellence: around the second person are placed things of the second order; and around the third those of the third degree (B)." Of this obscure passage a very satisfactory explanation is given in Dr Ogilvie's *Theology of Plato*, to which the narrow limits prescribed to such articles as this compel us to refer the reader. We shall only say, that the account which we have given of the Platonic Trinity is ably supported by the Doctor. Platonism.

In treating of the eternal emanation of the second and third Hypostases from the first, the philosophers of the academy compare them to light and heat proceeding from the sun. Plato himself, as quoted by Dr Cudworth, illustrates his doctrine by the same comparison. For "ταγαθον, or the first hypostasis, is in the intellectual world the same (he says) to intellect and intelligibles that the sun is in the corporeal world to vision and visibles; for as the sun is not vision itself but the cause of vision, and as that light by which we see is not the sun but only a thing like the sun; so neither is the Supreme or Highest Good properly knowledge, but the cause of knowledge; nor is intellect, considered as such, the best and most perfect being, but only a being having the form of perfection." Again, "as the sun causes other things not only to become visible but also to be generated; so the Supreme Good gives to things not only their capability of being known, but also their very essences by which they subsist; for this fountain of the Deity, this highest good, is not itself properly essence, but above essence, transcending it in respect both of dignity and of power."

The resemblance which this trinity of Plato bears to that revealed in the gospel must be observed by every attentive reader; but the two doctrines are likewise in some respects exceedingly dissimilar. The third hypostasis in the Platonic system appears in no point of view co-ordinate with the first or second. Indeed the first is elevated far above the second, and the third sunk still farther beneath it, being considered as a mere soul immersed in matter, and forming with the corporeal world, to which it is united, one compound animal. Nay, it does not appear perfectly clear, that Plato considered his ψυχη του κοσμου as a pure spirit, or as having subsisted from eternity as a distinct *Hypostasis*. "This governing spirit, of whom the earth, properly so called, is the body,

(B) "Περι των παντων βασιλε' α, παντ' εστι, και Εκειν υ ενεκα παντα. Εκεινος αιτια παντων των καλων. Δευτερον δε περι τα δευτερα, και τριτον περι τα τριτα." Oper. p. 1269.

body, consisted, according to our author's philosophy, of the same and the other; that is, of the first matter, and of pure intelligence, framed to actuate the machinery of nature. The Supreme Being placed him in the middle of the earth; which, in the vivid idea of Plato, seemed itself to live, in consequence of an influence that was felt in every part of it. From this seat his power is represented as being extended on all sides to the utmost limit of the heavens; conferring life, and preserving harmony in the various and complicated parts of the universe. Upon this being God is said to have looked with peculiar complacency after having formed him as an image of himself, and to have given beauty and perfect proportion to the mansion which he was destined to occupy. According to the doctrine of Timæus, the Supreme Being struck out from this original mind innumerable spirits of inferior order, endowed with principles of reason; and he committed to divinities of secondary rank the task of investing these in material forms, and of dispersing them as inhabitants of the sun, moon, and other celestial bodies. He taught also, that at death the human soul is reunited to the *ψυχη του κοσμου*, as to the source from which it originally came."

Such is the third person of the Platonic triad, as we find his nature and attributes very accurately stated by Dr Ogilvie; and the Christian philosopher, who has no particular system to support, will not require another proof that the triad of Plato differs exceedingly from the Trinity of the Scriptures. Indeed the third hypostasis in this triad has so much the appearance of all that the ancients could mean by that which we call a *creature*, that the learned Cudworth, who wished, it is difficult to conceive for what reason, to find the sublimest mystery of the Christian faith explicitly taught in the writings of a pagan philosopher, was forced to suppose that Plato held a double ψυχη or soul, one εγκοσμιον incorporated with the material world, and the other υπερκοσμιον or *supramundane*, which is not the soul but the governor of the universe. We call this a mere hypothesis; for though the author displays vast erudition, and adduces many quotations in which this double *psyche* is plainly mentioned, yet all those quotations are taken from Platonists who lived after the propagation of the gospel, and who, calling themselves *ecclectics*, freely stole from every sect such dogmas as they could incorporate with their own system, and then attributed those dogmas to their master. In the writings of Plato himself, there is not so much as an allusion to this supramundane *psyche**; and it is for this reason (the ψυχη, of which he treats being so very inferior to the δημιουργος and ταγαθον) that we have expressed with hesitation his belief of *three* hypostases in the divine nature. Yet that he did admit so many, seems more than probable both from the passage illustrated by Dr Ogilvie and from the attempt of Plotinus, one of his followers, to demonstrate that the number can be neither greater nor less. That his doctrine on this subject should be inaccurate and erroneous, can excite no wonder; whilst it must be confessed to have such a resemblance to the truth, and to be so incapable of being proved by reasoning from effects to causes, that we could not doubt of his having inherited it by tradition, even though we had not complete evidence that something very similar to it was taught long before him, not only by Pythagoras and Parmenides, but by the philosophers of the east.

* *Mosch. ed. Cud. Syst. Intel* c. 4 § 36. n. 43.

We have said that the Demiurgus was the maker of the world from the first matter which had existed from eternity; but in Plato's cosmogony there is another principle, more mysterious, if possible, than any thing which we have yet mentioned. This is his intellectual system of *ideas*, which it is not easy to collect from his writings, whether he considered as *independent* existences, or only as archetypal *forms*, which had subsisted from eternity in the λογος or divine intellect. On this subject he writes with such exceeding obscurity, that men of the first eminence, both among the ancients and the moderns, have differed about his real meaning. Some have supposed, that by *ideas* he meant real beings subsisting from eternity, independent of all minds, and separate from all matter; and that of these ideas he conceived some to be living and others to be without life. In this manner his doctrine is interpreted by Tertullian* among the ancients, and by the celebrated Bruckert† among the moderns; and not by them only, but by many others equally learned, candid, and acute. Cudworth, on the other hand, with his annotator Mosheim, contend, that by his ideal world Plato meant nothing more than that there existed from eternity in the λογος or mind of God a notion or conception of every thing which was in time to be made. This is certainly much more probable in itself, than that a man of enlarged understanding should have supposed, that there are somewhere in extramundane space real living incorporeal beings eating and drinking, which are the *ideas* of all the animals which ever have been or ever will be eating and drinking in this world. Yet Mosheim candidly acknowledges, that if the controversy were to be decided by the votes of the learned, he is doubtful whether it would be given for or against him; and Cudworth, though he pleads the cause of his master with much ingenuity, owns, that on this subject his language cannot be vindicated. This indeed is most true; for Plato contends, that his ideas are not only the objects of science, but also the proper or physical causes of all things here below; that the *idea* of similitude is the *cause* of the resemblance between two globes; and the *idea* of dissimilitude the cause that a globe does not resemble a pyramid: he likewise calls them ουσιας, *essences* or *substances*, and many of his followers have pronounced them to be *animals*.

* *Lib. Anima.*

† *Histor. Doctrin. Idæis.*

These wonderful expressions incline us to adopt with some hesitation the opinion stated by Dr Enfield. This historian of philosophy having observed, that some of the admirers of Plato contend, that by ideas existing in the reason of God, nothing more is meant than conceptions formed in the Divine mind, controverts this opinion with much effect. "By ideas, Plato (says he) appears to have meant something much more mysterious; namely, patterns or archetypes subsisting by themselves, as real beings, οντως οντα in the Divine reason, as in their original and eternal region, and issuing thence to give form to sensible things, and to become objects of contemplation and science to rational beings. It is the doctrine of the Timæus, that ὁ λογισμος τυ Θευ, the reason of God, comprehends exemplars of all things, and that this reason is one of the primary causes of things. Plutarch says, that Plato supposes three principles, God, Matter, and Idea. Justin Martyr, Pseudo-Origen, and others, assert the same thing.

"That this is the true Platonic doctrine of ideas will appear

Platonism. appear probable, if we attend to the manner in which Plato framed his system of opinions concerning the origin of things. 'Having been from his youth (says Aristotle) conversant with Cratylus, a disciple of Heraclitus, and instructed in the doctrine of that school, that all sensible things are variable, and cannot be proper objects of science, he reasonably concluded, that if there be any such thing as science, there must exist, besides sensible objects, certain permanent natures, perceptible only by the intellect.' Such natures, divine in their origin, and eternal and immutable in their existence, he admitted into his system, and called them *ideas*. Visible things were regarded by Plato as fleeting shades, and ideas as the only permanent substances. These he conceived to be the proper objects of science to a mind raised by divine contemplation above the perpetually varying scenes of the material world."

It was a fundamental doctrine in the system of Plato, that the Deity formed the material world after a perfect model, consisting of those ideas which had eternally subsisted in his own reason; and yet, with some appearance of contradiction, he calls this model "*self*-existent, indivisible, and eternally *generated*." Nay, he talks of it as being intelligent as well as eternal, and wholly different from the transcripts, which are subjected to our inspection. There is so much mystery, confusion, and apparent absurdity, in the whole of this system, as it has come down to us, that we must suppose the friends of Plato to have been intrusted with a key to his esoteric doctrines, which has long been lost, otherwise it would be difficult to conceive how that philosopher could have had so many admirers.

With almost every ancient theist of Greece the founder of the academy believed in an order of beings called *dæmons*, which were superior to the souls of men, and struck off by the Demiurgus from the soul of the world. Of these the reader will find some account elsewhere: (See Dæmon and Polytheism). We mention them at present because they make an important appearance in Plato's system of physics, which was built upon them and upon the doctrine which has been stated concerning God, matter, and ideas. He taught, that the visible world was formed by the Supreme Architect, uniting eternal and immutable ideas to the first matter; that the universe is one animated being*, including within its limits all animated natures; that, in the formation of the visible and tangible world, fire and earth were first formed, and were afterwards united by means of air and water; that from perfect parts one perfect whole was produced, of a spherical figure, as most beautiful in itself, and best suited to contain all other figures†; that the elementary parts of the world are of regular geometrical forms, the particles of earth being cubical, those of fire pyramidical, those of air in the form of an octohedron, and those of water in that of an icosohedron; that these are adjusted in number, measure, and power, in perfect conformity to the geometrical laws of proportion; that the soul which pervades this sphere is the cause of its revolution round its centre; and, lastly, that the world will remain for ever, but that by the action of its animating principle, it accomplishes certain periods, within which every thing returns to its ancient place and state. This periodical revolution of nature is called the *Platonic* or *great year*. See the preceding article.

* *Tim.*

† *Ibid.*

The metaphysical doctrines of Plato, which treat of the human soul, and the principles of his system of ethics, have been detailed in other articles (See Metaphysics, Part III. chap. iv.; and Moral *Philosophy*, nº 6.): but it is worthy of observation in this place, that, preparatory to the study of all philosophy, he required from his disciples a knowledge of the elements of mathematics. In his Republic, he makes Glaucus, one of the speakers, recommend them for their usefulness in human life. "Arithmetic for accounts and distributions; geometry for incampments and mensurations; music for solemn festivals in honour of the gods; and astronomy for agriculture, for navigation, and the like. Socrates, on his part, denies not the truth of all this, but still insinuates that they were capable of answering an end more sublime. 'You are pleasant (says he) in your seeming to fear the multitude, lest you should be thought to enjoin certain sciences that are useless. 'Tis indeed no contemptible matter, though a difficult one, to believe, that through these particular sciences the soul has an organ purified and enlightened, which is destroyed and blinded by studies of other kinds; an organ better worth saving than a thousand eyes, in as much as *truth* becomes visible through *this alone*."

"Concerning policy, Plato has written at large in his Republic and in his Dialogue on Laws. He was so much enamoured with his own conceptions on this subject, that it was chiefly the hope of having an opportunity to realise his plan of a republic which induced him to visit the court of Dionysius. But they who are conversant with mankind, and capable of calmly investigating the springs of human actions, will easily perceive that his projects were chimerical, and could only have originated in a mind replete with philosophical enthusiasm. Of this nothing can be a clearer proof than the design of admitting in his republic a community of women, in order to give reason an entire controul over desire. The main object of his political institutions appears to have been, the subjugation of the passions and appetites, by means of the abstract contemplation of ideas. A system of policy, raised upon such fanciful grounds, cannot merit a more distinct consideration."

Such is genuine Platonism as it was taught in the old academy by the founder of the school and his immediate followers; but when Arcesilaus was placed at the head of the academics, great innovations were introduced both into their doctrines and into their mode of teaching (See Arcesilaus). This man was therefore considered as the founder of what was afterwards called the *middle* academy. Being a professed sceptic, he carried his maxim of uncertainty to such a height, as to alarm the general body of philosophers, offend the governors of the state, and bring just odium upon the very name of the academy. At length *Carneades*, one of the disciples of this school, relinquishing some of the more obnoxious tenets of Arcesilaus, founded what has been called the *new* academy with very little improvement on the principles of the middle. See Carneades.

Under one or other of these forms Platonism found its way into the Roman republic. Cicero was a Platonist, and one of the greatest ornaments of the school. A school of Platonists was likewise founded in Alexandria in the second century of the Christian era; but their doctrines differed in many particulars from those taught in

in the three academies. They professed to seek truth wherever they could find it, and to collect their dogmas from every school. They endeavoured to bend some of the principles of Plato into a conformity with the doctrines of the gospel; and they incorporated with the whole many of the maxims of Aristotle and Zeno, and not a few of the fictions of the east. Their system was therefore extremely heterogeneous, and seldom so rational as that of the philosopher after whose name they were called, and of whose doctrines we have given so copious a detail. See AMMONIUS, ECCLECTICS, and PLOTINUS.

PLAUTUS (Marcus Accius), a comic writer of ancient Rome, born at Umbria, a province of Italy. His proper name was *Marcus Accius*, and he is supposed to have acquired the surname of *Plautus* from having splay feet. His parentage appears to have been mean; so that some have thought he was the son of a slave. Aulus Gellius says that Plautus was distinguished for his poetry on the theatre, and Cato for his eloquence in the Forum, at the same time; and observes elsewhere from Varro, that he was so well paid for his plays as to double his stock in trading, in which he lost all he gained by the muses. He is said to have been reduced to work at a mill for his subsistence; but Varro adds, that his wit was his best support, as he composed three of his plays during this drudgery. He died in the first year of the elder Cato's censorship, about the year of Rome 569, and 184 B. C. We have 20 of his plays extant, though not all of them entire. Five of them, comedies, have been elegantly translated into English by Mr B. Thornton, and published in 2 vols 8vo, 1767.

PLAYS. See PLAY-HOUSE.

PLAY-HOUSE. See THEATRE, AMPHITHEATRE, &c. The most ancient English play-houses were the Curtain in Shoreditch and the Theatre. In the time of Shakespeare, who commenced a dramatic writer in 1592, there were no less than 10 theatres open. Four of these were private houses, viz. that in Blackfriars, the Cockpit or Phœnix in Drury-Lane, a theatre in Whitefriars, and one in Salisbury court. The other six were called public theatres, viz. the Globe, the Swan, the Rose, and the Hope, on the Bank-side; the Red Bull, at the upper end of St John's-street, and the Fortune in White-cross Street. The two last were chiefly frequented by citizens. Mr Malone gives us a pretty copious account of these play-houses, in a supplement to his last edition of Shakespeare, which we shall here insert.

"Most, if not all (says he) of Shakespeare's plays were performed either at the Globe or at the Theatre in Blackfriars. It appears that they both belonged to the same company of comedians, viz. his majesty's servants, which title they assumed, after a licence had been granted to them by King James in 1603, having before that time been called the servants of the lord chamberlain.

"The theatre in Blackfriars was a private house; but the peculiar and distinguishing marks of a private play-house it is not easy to ascertain. It was very small, and plays were there usually represented by candle light. The Globe, situated on the southern side of the river Thames, was a hexagonal building, partly open to the weather, partly covered with reeds. It was a public theatre, and of considerable size, and there they always acted by day-light. On the roof of the Globe, and the other public theatres, a pole was erected, to which a flag was affixed. These flags were probably displayed only during the hours of exhibition; and it should seem from a passage in one of the old comedies that they were taken down during Lent, in which season no plays were presented. The Globe, though hexagonal at the outside, was probably a rotunda within, and perhaps had its name from its circular form. It might, however, have been denominated only from its sign, which was a figure of Hercules supporting the Globe. This theatre was burnt down in 1613, but it was rebuilt in the following year, and decorated with more ornament than had been originally bestowed upon it. The exhibitions at the Globe seem to have been calculated chiefly for the lower class of people; those at Blackfriars for a more select and judicious audience.

"A writer informs us, that one of these theatres was a winter and the other a summer house. As the Globe was partly exposed to the weather, and they acted there usually by day-light, it was probably the summer theatre. The exhibitions here seem to have been more frequent than at Blackfriars, at least till the year 1604 or 1605, when the Bank-side appears to have become less fashionable and less frequented than it formerly had been. Many of our ancient dramatic pieces were performed in the yards of carriers inns; in which, in the beginning of queen Elizabeth's reign, the comedians, who then first united themselves in companies, erected an occasional stage. The form of these temporary play-houses seems to be preserved in our modern theatre. The galleries are in both ranged over each other on three sides of the building. The small rooms under the lowest of these galleries answer to our present boxes; and it is observable that these, even in theatres which were built in a subsequent period expresly for dramatic exhibitions, still retained their old name, and are frequently called rooms by our ancient writers. The yard bears a sufficient resemblance to the pit, as at present in use. We may suppose the stage to have been raised in this area, on the fourth side, with its back to the gateway of the inn, at which the money for admission was taken. Hence, in the middle of the Globe, and I suppose of the other public theatres, in the time of Shakespeare, there was an open yard or area, where the common people stood to see the exhibition; from which circumstance they are called by our author groundlings, and by Ben Johnson 'the understanding gentlemen of the ground.'

"In the ancient play-houses there appears to have been a private box, of which it is not easy to ascertain the situation. It seems to have been placed at the side of the stage towards the rear, and to have been at a lower price: in this some people sat, either from economy or singularity. The galleries, or scaffolds as they are sometimes called, and that part of the house which in private theatres was named the pit, seem to have been at the same price; and probably in houses of reputation, such as the Globe, and that in Blackfriars, the price of admission into those parts of the theatre was 6 d. while in some meaner play-houses it was only 1 d. in others only 2 d. The price of admission into the best rooms or boxes was, I believe, in our author's time, 1 s.; though after-

Play-house. afterwards it appears to have risen to 2 s. and half-a-crown.

"From several passages in our old plays, we learn, that spectators were admitted on the stage, and that the critics and wits of the time usually sat there. Some were placed on the ground; others sat on stools, of which the price was either 6 d. or 1 s. according, I suppose, to the commodiousness of the situation; and they were attended by pages, who furnished them with pipes and tobacco, which was smoaked here as well as in other parts of the house; yet it should seem that persons were suffered to sit on the stage only in the private play-houses, such as Blackfriars, &c. where the audience was more select, and of a higher class; and that in the Globe and other public theatres no such licence was permitted.

"The stage was strewed with rushes, which, as we learn from Hentzner and Caius de Ephemera, was, in the time of Shakespeare, the usual covering of floors in England. The curtain which hangs in the front of the present stage, drawn up by lines and pulleys, though not a modern invention, for it was used by Inigo Jones in the masques at court, was yet an apparatus to which the simple mechanism of our ancient theatres had not arrived, for in them the curtains opened in the middle, and were drawn backwards and forwards on an iron rod. In some play-houses they were woollen, in others made of silk.—Towards the rear of the stage there appears to have been a balcony, the platform of which was probably eight or ten feet from the ground. I suppose it to have been supported by pillars. From hence, in many of our old plays, part of the dialogue was spoken; and in the front of this balcony curtains likewise were hung.

"A doubt has been entertained whether in our ancient theatres there were side and other scenes. The question is involved in so much obscurity, that it is very difficult to form any decided opinion upon it. It is certain, that in the year 1605 Inigo Jones exhibited an entertainment at Oxford, in which moveable scenes were used; but he appears to have introduced several pieces of machinery in the masques at court, with which undoubtedly the public theatres were unacquainted. A passage which has been produced from one of the old comedies, proves, it must be owned, that even these were furnished with some pieces of machinery, which were used when it was requisite to exhibit the descent of some god or saint; but from all the contemporary accounts, I am inclined to believe that the mechanism of our ancient stage seldom went beyond a painted chair or a trap-door, and that few, if any of them, had any moveable scenes. When king Henry VIII. is to be discovered by the dukes of Suffolk and Norfolk, reading in his study, the scenical direction in the first folio, 1623, (which was printed apparently from play-house copies), is, 'the king draws the curtain, (*i. e.* draws it open), and sits reading pensively;' for, besides the principal curtains that hung in the front of the stage, they used others as substitutes for scenes. If a bed-chamber is to be exhibited, no change of scene is mentioned; but the property-man is simply ordered to thrust forth a bed. When the fable requires the Roman capitol to be exhibited, we find two officers enter, 'to lay cushions, as it were, in the capitol,' &c. On the whole, it appears, that our ancient theatres, in general, were only furnished with curtains, and a single scene composed of tapestry, which were sometimes, perhaps, ornamented with pictures; and some passages in our old dramas incline one to think, that when tragedies were performed the stage was hung with black. Play-house.

"In the early part, at least, of our author's ‡ acquaintance with the theatre, the want of scenery seems to have been supplied by the simple expedient of writing the names of the different places where the scene was laid in the progress of the play, which were disposed in such a manner as to be visible to the audience. The invention of trap-doors, however, appears not to be modern; for in an old *morality*, intitled *All for Money*, we find a marginal direction which implies that they were very early in use. The covering, or internal roof of the stage, was anciently termed the heavens. It was probably painted of a sky-blue colour, or perhaps pieces of drapery tinged with blue were suspended across the stage to represent the heavens.

‡ *Shakespeare.*

"It is probable that the stage was formerly lighted by two large branches, of a form similar to those now hung in churches. They gave place in a subsequent period to small circular wooden frames, furnished with candles, eight of which were hung on the stage, four at either side, and these within a few years were wholly removed by Mr Garrick, who, on his return from France, first introduced the present commodious method of illuminating the stage by lights not visible to the audience. Many of the companies of players were formerly so thin, that one person played two or three parts; and a battle on which the fate of an empire was supposed to depend was decided by half a dozen combatants. It appears to have been a common practice in their mock engagements to discharge small pieces of ordnance on the stage. Before the exhibition began, three flourishes or pieces of music were played, or, in the ancient language, there were three soundings. Music was likewise played between the acts. The instruments chiefly used were trumpets, cornets, and hautboys. The band, which did not consist of more than five or six performers, sat in an upper balcony, over what is now called the stage-box.

"The person who spoke the prologue was ushered in by trumpets, and usually wore a long black velvet cloak, which, I suppose, was considered as best suited to a supplicatory address. Of this custom, whatever might have been its origin, some traces remained till very lately, a black coat having been, if I mistake not, within these few years, the constant stage-habiliment of our modern prologue-speakers. The dress of the ancient prologue-speaker is still retained in the play that is exhibited in Hamlet before the king and court of Denmark. The performers of male characters generally wore periwigs, which in the age of Shakespeare were not in common use. It appears, from a passage in Puttenham's *Art of English Poesy*, 1589, that vizards were on some occasions used by the actors of those days; and it may be inferred, from a scene in one of our author's comedies, that they were sometimes worn in his time by those who performed female characters; but this I imagine was very rare. Some of the female part of the audience likewise appeared in masks. The stage-dresses, it is reasonable to suppose, were much more costly at some theatres than at others; yet the wardrobe of even the king's servants at the Globe and Blackfriars, was, we find, but scantily furnished; and our author's dramas derived very little aid from the splendor of exhibition.

"It is well known, that in the time of Shakespeare, and for many years afterwards, female characters were repre-

Play-houſe. repreſented by boys or young men. Sir William D'Avenant, in imitation of the foreign theatres, firſt introduced females in the ſcene, and Mrs Betterton is ſaid to have been the firſt woman that appeared on the Engliſh ſtage. Andrew Pennycuicke played the part of Matilda in a tragedy of Davenport's, in 1655; and Mr Kynaſton acted ſeveral female parts after the Reſtoration. Downes, a contemporary of his, aſſures us, 'that being then very young he made a complete ſtage beauty, performing his parts ſo well, particularly Arthiope and Aglaura, that it has ſince been diſputable among the judicious whether any woman that ſucceeded him touched the audience ſo ſenſibly as he.'

"Both the prompter, or book-holder, as he was ſometimes called, and the property-man, appear to have been regular appendages of our ancient theatres. No writer that I have met with intimates, that in the time of Shakeſpeare it was cuſtomary to exhibit more than a ſingle dramatic piece on one day. The Yorkſhire tragedy, or *All's One*, indeed, appears to have been one of four pieces that were repreſented on the ſame day; and Fletcher has alſo a piece called *Four Plays in One;* but probably theſe were either exhibited on ſome particular occaſion, or were ineffectual efforts to introduce a new ſpecies of amuſement; for we do not find any other inſtances of the ſame kind. Had any ſhorter pieces been exhibited after the principal performance, ſome of them probably would have been printed: but there are none extant of an earlier date than the time of the Reſtoration. The practice, therefore, of exhibiting two dramas ſucceſſively in the ſame evening, we may be aſſured was not eſtabliſhed before that period. But though the audiences in the time of our author were not gratified by the repreſentation of more than one drama in the ſame day, the entertainment was diverſified, and the populace diverted, by vaulting, tumbling, ſlight of hand, and morris-dancing, a mixture not much more heterogeneous than that with which we are daily preſented, a tragedy and a farce.

"The amuſements of our anceſtors, before the commencement of the play, were of various kinds, ſuch as reading, playing at cards, drinking ale, or ſmoaking tobacco. It was a common practice to carry table-books to the theatre, and either from curioſity or enmity to the author, or ſome other motive, to write down paſſages of the play that was repreſented: and there is reaſon to believe that the imperfect and mutilated copies of ſome of Shakeſpeare's dramas, which are yet extant, were taken down in ſhort-hand during the exhibition. At the end of the piece, the actors, in noblemens houſes and in taverns, where plays were frequently performed, prayed for the health and proſperity of their patrons; and in the public theatres for the king and queen. This prayer ſometimes made part of the epilogue. Hence, probably, as Mr Steevens has obſerved, the addition of *Vivant rex et regina* to the modern play-bills.

"Plays, in the time of our author, began at one o'clock in the afternoon; and the exhibition was uſually finiſhed in two hours. Even in 1667 they commenced at three. When Goſſon wrote his *School of Abuſe* in 1579, it ſeems the dramatic entertainments were uſually exhibited on Sundays. Afterwards they were performed on that and other days indiſcriminately. It appears from a contemporary writer, that exhibiting plays on Sunday had not been aboliſhed in the third year of king Charles I.

"The modes of conveyance to the theatre, anciently as at preſent, ſeem to have been various; ſome going in coaches, others on horſeback, and many by water.— To the Globe play-houſe the company probably were conveyed by water; to that in Blackfriars the gentry went either in coaches or on horſeback, and the common people on foot. In an epigram to Sir John Davis, the practice of riding to the theatre is ridiculed as a piece of affectation or vanity, and therefore we may preſume it was not very general.

"The long and whimſical titles that are prefixed to the quarto copies of our author's plays, I ſuppoſe to have been tranſcribed from the play-bills of the time. A contemporary writer has preſerved ſomething like a play-bill of thoſe days, which ſeems to corroborate this obſervation; for if it were diveſted of rhime, it would bear no very diſtant reſemblance to the title pages that ſtand before ſome of our author's dramas:

"———Prithee, what's the play?
"(The firſt I viſited this twelvemonth day)
"They ſay—"A new invented play of Purle,
"That jeoparded his neck to ſteal a girl
"Of twelve; and lying faſt impounded for't,
"Has hither ſent his bearde to act his part;
"Againſt all thoſe in open malice bent,
"That would not freely to the theft conſent:
"Feigns all to's wiſh, and in the epilogue
"Goes out applauded for a famous—rogue."
"—Now hang me if I did not look at firſt
"For ſome ſuch ſtuff, by the fond people's thruſt."

"It is uncertain at what time the uſage of giving authors a benefit on the third day of the exhibition of their pieces commenced. Mr Oldys, in one of his manuſcripts, intimates that dramatic poets had anciently their benefit on the firſt day that a new play was repreſented; a regulation which would have been very favourable to ſome of the ephemeral productions of modern times. But for this there is not, I believe, any ſufficient authority. From D'Avenant, indeed, we learn, that in the latter part of the reign of queen Elizabeth the poet had his benefit on the ſecond day. As it was a general practice in the time of Shakeſpeare to ſell the copy of the play to the theatre, I imagine in ſuch caſes an author derived no other advantage from his piece than what aroſe from the ſale of it. Sometimes, however, he found it more beneficial to retain the copyright in his own hands; and when he did ſo, I ſuppoſe he had a benefit. It is certain that the giving authors the profit of the third exhibition of their play, which ſeems to have been the uſual mode during almoſt the whole of the laſt century, was an eſtabliſhed cuſtom in the year 1612; for Decker, in the prologue to one of his comedies printed in that year, ſpeaks of the poet's third day. The unfortunate Otway had no more than one benefit on the production of a new play; and this too, it ſeems, he was ſometimes forced to mortgage before the piece was acted. Southerne was the firſt dramatic writer who obtained the emoluments ariſing from two repreſentations; and to Farquhar, in the year 1700, the benefit of a third was granted. When an author ſold his piece to the ſharers or proprietors of a theatre, it remained for ſeveral years unpubliſhed; but when that was not the caſe, he printed it for ſale, to which many ſeem to have been induced, from an apprehenſion that an imperfect copy might be iſſued from the preſs without

house, out their consent. The customary price of the copy of a play in the time of Shakespeare appears to have been twenty nobles, or six pounds thirteen shillings and four pence. The play when printed was sold for sixpence; and the usual present from a patron in return for a dedication was forty shillings. On the first day of exhibiting a new play, the prices of admission appear to have been raised; and this seems to have been occasionally practised on the benefit-nights of authors to the end of the last century. The custom of passing a final censure on plays at their first exhibition is as ancient as the time of our author; for no less than three plays of his rival Ben Jonson appear to have been damned; and Fletcher's Faithful Shepherdess, and The Knight of the Burning Pestle, written by him and Beaumont, underwent the same fate.

"It is not easy to ascertain what were the emoluments of a successful actor in the time of Shakespeare. They had not then annual benefits as at present. The performers at each theatre seem to have shared the profits arising either from each day's exhibition or from the whole season among them. From Ben Jonson's Poetaster we learn, that one of either the performers or proprietors had seven shares and a half; but of what integral sum is not mentioned. From the prices of admission into our ancient theatres, which have been already mentioned, I imagine the utmost that the sharers of the Globe play-house could have received on any one day was about L. 35. So lately as the year 1685, Shadwell received by his third day on the representation of the Squire of Alsatia, L. 130; which Downes the prompter says was the greatest receipt that had been ever taken at Drury-Lane playhouse at single prices. It appears from the MSS. of Lord Stanhope, treasurer of the chambers to King James I. that the customary sum paid to John Heminge and his company for the performance of a play at court was twenty nobles, or six pounds thirteen shillings and four pence. And Edward Alleyn mentions in his Diary, that he once had so slender an audience in his theatre called the *Fortune*, that the whole receipts of the house amounted to no more than three pounds and some odd shillings.

"Thus scanty and meagre were the apparatus and accommodations of our ancient theatres, on which those dramas were first exhibited, that have since engaged the attention of so many learned men, and delighted so many thousand spectators. Yet even then, we are told by a writer of that age, 'that dramatic poesy was so lively expressed and represented on the public stages and theatres of this city, as Rome in the age of her pomp and glory never saw it better performed; in respect of the action and art, not of the cost and sumptuousness.'"

Plea.

PLEA, in law, is what either party alleges for himself in court, in a cause there depending; and in a more restrained sense, it is the defendant's answer to the plaintiff's declaration.

Pleas are usually divided into those of the crown and common pleas. Pleas of the crown are all suits in the king's name, or in the name of the attorney-general in behalf of the king, for offences committed against his crown and dignity, and against his peace; as treason, murder, felony, &c. See ARRAIGNMENT.

Common pleas are such suits as are carried on between common persons in civil cases. These pleas are of two sorts; *dilatory* pleas, and pleas *to the action*. Dilatory pleas are such as tend merely to delay or put off the suit, by questioning the propriety of the remedy, rather than by denying the injury: pleas to the action are such as dispute the very cause of suit.

Plea.

I. *Dilatory* pleas are, 1. To the jurisdiction of the court: alleging, that it ought not to hold plea of this injury, it arising in Wales or beyond sea; or because the land in question is of ancient demesne, and ought only to be demanded in the lord's court, &c. 2. To the disability of the plaintiff, by reason whereof he is incapable to commence or continue the suit; as, that he is an alien enemy, outlawed, excommunicated, attainted of treason or felony, under a præmunire, not *in rerum natura* (being only a fictitious person), an infant, a feme-covert, or a monk professed. 3. In abatement: which abatement is either of the writ, or the count, for some defect in one of them; as by misnaming the defendant, which is called a *misnomer*; giving him a wrong addition, as esquire instead of knight; or other want of form in any material respect. Or, it may be that the plaintiff is dead; for the death of either party is at once an abatement of the suit.

These pleas to the jurisdiction, to the disability, or in abatement, were formerly very often used as mere dilatory pleas, without any foundation in truth, and calculated only for delay; but now by stat. 4 & 5 Ann. c. 16. no dilatory plea is to be admitted without affidavit made of the truth thereof, or some probable matter shown to the court to induce them to believe it true. And with respect to the pleas themselves, it is a rule, that no exception shall be admitted against a declaration or writ, unless the defendant will in the same plea give the plaintiff a better; that is, show him how it might be amended, that there may not be two objections upon the same account.

All pleas to the jurisdiction conclude to the cognizance of the court; praying "judgment whether the court will have farther cognizance of the suit." Pleas to the disability conclude to the person; by praying "judgment, if the said A the plaintiff ought to be answered:" And pleas in abatement (when the suit is by original) conclude to the writ or declaration; by praying "judgment of the writ, or declaration, and that the same may be quashed," *cassetur*, made void, or abated: but if the action be by bill, the plea must pray "judgement of the bill," and not of the declaration; the bill being here the original, and the declaration only a copy of the bill.

When these dilatory pleas are allowed, the cause is either dismissed from that jurisdiction, or the plaintiff is stayed till his disability be removed; or he is obliged to sue out a new writ, by leave obtained from the court, or to amend and new-frame his declaration. But when, on the other hand, they are over-ruled as frivolous, the defendant has judgment of *respondeat ouster*, or to answer over in some better manner. It is then incumbent on him to plead.

2. A plea *to the action*; that is, to answer to the merits of the complaint. This is done by confessing or denying it.

A confession of the whole complaint is not very usual; for then the defendant would probably end the matter sooner, or not plead at all, but suffer judgment to go by

Plea. by default. Yet ſometimes, after tender and refuſal of a debt, if the creditor haraſſes his debtor with an action, it then becomes neceſſary for the defendant to acknowledge the debt, and plead the tender; adding, that he has always been ready, *tout temps priſt*, and is ſtill ready, *uncore priſt*, to diſcharge it: for a tender by the debtor and refuſal by the creditor will in all caſes diſcharge the coſts, but not the debt itſelf; though in ſome particular caſes the creditor will totally loſe his money. But frequently the defendant confeſſes one part of the complaint (by a *cognovit actionem* in reſpect thereof), and traverſes or denies the reſt; in order to avoid the expence of carrying that part to a formal trial, which he has no ground to litigate. A ſpecies of this ſort of confeſſion is the *payment of money into court:* which is for the moſt part neceſſary upon pleading a tender, and is itſelf a kind of tender to the plaintiff; by paying into the hands of the proper officer of the court as much as the defendant acknowledges to be due, together with the coſts hitherto incurred, in order to prevent the expence of any farther proceedings. This may be done upon what is called a *motion;* which is an occaſional application to the court by the parties or their counſel, in order to obtain ſome rule or order of court, which becomes neceſſary in the progreſs of a cauſe; and it is uſually grounded upon an *affidavit* (the perfect tenſe of the verb *affido*), being a voluntary oath before ſome judge or officer of the court, to evince the truth of certain facts, upon which the motion is grounded: though no ſuch affidavit is neceſſary for payment of money into court. If, after the money is paid in, the plaintiff proceeds in his ſuit, it is at his own peril: for if he does not prove more due than is ſo paid into court, he ſhall be nonſuited and pay the defendant's coſts; but he ſhall ſtill have the money ſo paid in, for that the defendant has acknowledged to be his due. To this head may alſo be referred the practice of what is called a *ſet off;* whereby the defendant acknowledges the juſtice of the plaintiff's demand on the one hand; but on the other, ſets up a demand of his own, to counterbalance that of the plaintiff, either in the whole or in part; as, if the plaintiff ſues for ten pounds due on a note of hand, the defendant may ſet off nine pounds due to himſelf for merchandize ſold to the plaintiff; and, in caſe he pleads ſuch ſet-off, muſt pay the remaining balance into court.

Pleas that totally deny the cauſe of complaint are either the general iſſue, or a ſpecial plea in bar.

1. The *general iſſue*, or general plea, is what traverſes, thwarts, and denies at once, the whole declaration, without offering any ſpecial matter whereby to evade it. As in treſpaſs either *vi et armis*, or on the caſe, "*non culpabilis*, not guilty;" in debt upon contract, "*nihil debet*, he owes nothing;" in debt on bond, "*non eſt factum*, it is not his deed;" on an *aſſumpſit*, "*non aſſumpſit*, he made no ſuch promiſe." Or in real actions, "*nul tort*, no wrong done; *nul diſſeiſin*, no diſſeiſin;" and in a writ of right, the miſe or iſſue is, that "the tenant has more right to hold than the demandant has to demand." Theſe pleas are called the *general iſſue*, becauſe, by importing an abſolute and general denial of what is alleged in the declaration, they amount at once to an iſſue; by which we mean a fact affirmed on one ſide and denied on the other.

2. *Special* pleas in bar of the plaintiff's demands are very various, according to the circumſtances of the defendant's caſe. As, in real actions, a general releaſe or a fine; both of which may deſtroy and bar the plaintiff's title. Or, in perſonal actions, an accord, arbitration, conditions performed, nonage of the defendant, or ſome other fact which precludes the plaintiff from his action. A *juſtification* is likewiſe a ſpecial plea in bar; as in actions of aſſault and battery, *ſon aſſault demeſne*, that it was the plaintiff's own original aſſault; in treſpaſs, that the defendant did the thing complained of in right of ſome office which warranted him ſo to do; or, in an action of ſlander, that the plaintiff is really as bad a man as the defendant ſaid he was.

Plea. Alſo a man may plead the ſtatutes of limitation in bar; or the time limited by certain acts of parliament, beyond which no plaintiff can lay his cauſe of action. This, by the ſtatute of 32 Hen. VIII. c. 2. in a writ of right is 60 years: in aſſiſes, writs of entry, or other poſſeſſory actions real, of the ſeiſin of one's anceſtors in lands; and either of their ſeiſin, or one's own, in rents, ſuits, and ſervices, 50 years: and in actions real for lands grounded upon one's own ſeiſin or poſſeſſion, ſuch poſſeſſion muſt have been within 30 years. By ſtatute 1 Mar. ſt. 2. c. 5. this limitation does not extend to any ſuit for avowſons. But by the ſtatute 21 Jac. I. c. 2. a time of limitation was extended to the caſe of the king; viz. 60 years precedent to 19th Feb. 1623: but, this becoming ineffectual by efflux of time, the ſame date of limitation was fixed by ſtatute 9 Geo. III. c. 16. to commence and be reckoned backwards, from the time of bringing any ſuit or other proceſs to recover the thing in queſtion; ſo that a poſſeſſion for 60 years is now a bar even againſt the prerogative, in derogation of the ancient maxim, *Nullum tempus occurrit regi.* By another ſtatute, 21 Jac. I. c. 16. 20 years is the time of limitation in any writ of formedon: and, by a conſequence, 20 years is alſo the limitation in every action of ejectment; for no ejectment can be brought, unleſs where the leſſor of the plaintiff is intitled to enter on the lands, and by the ſtatute 21 Jac. I. c. 16. no entry can be made by any man, unleſs within 20 years after his right ſhall accrue. Alſo all actions of treſpaſs (*quare clauſum fregit*, or otherwiſe), detinue, trover, replevin, account, and caſe (except upon accounts between merchants), debt on ſimple contract, or for arrears of rent, are limited by the ſtatute laſt mentioned to ſix years after the cauſe of action commenced: and actions of aſſault, menace, battery, mayhem, and impriſonment, muſt be brought within four years, and actions for words two years, after the injury committed. And by the ſtatute 31 Eliz. c. 5. all ſuits, indictments, and informations, upon any penal ſtatutes, where any forfeiture is to the crown, ſhall be ſued within two years, and where the forfeiture is to a ſubject, within one year, after the offence committed, unleſs where any other time is ſpecially limited by the ſtatute. Laſtly, by ſtatute 10 W. III. c. 14. no writ of error, *ſcire facias*, or other ſuit, ſhall be brought to reverſe any judgment, fine, or recovery, for error, unleſs it be proſecuted within 20 years. The uſe of theſe ſtatutes of limitation is to preſerve the peace of the kingdom, and to prevent thoſe innumerable perjuries which might enſue if a man were allowed to bring an action for any injury committed at any diſtance of time. Upon both theſe accounts the law therefore holds, that *intereſt reipublicæ ut ſit finis litium:* and upon the ſame principle the Athenian laws in general prohibited

hibited all actions where the injury was committed five years before the complaint was made. If therefore, in any ſuit, the injury, or cauſe of action, happened earlier than the period expreſsly limited by law, the defendant may plead the ſtatutes of limitations in bar: as upon an *aſſumpſit*, or promiſe to pay money to the plaintiff, the defendant may plead, *Non aſſumpſit infra ſex annos*, He made no ſuch promiſe within ſix years; which is an effectual bar to the complaint.

An *eſtoppel* is likewiſe a ſpecial plea in bar; which happens where a man hath done ſome act, or executed ſome deed, which eſtops or precludes him from averring any thing to the contrary. As if a tenant for years (who hath no freehold) levies a fine to another perſon. Tho' this is void as to ſtrangers, yet it ſhall work as an eſtoppel to the cognizor; for, if he afterwards brings an action to recover theſe lands, and his fine is pleaded againſt him, he ſhall thereby be eſtopped from ſaying, that he had no freehold at the time, and therefore was incapable of levying it.

The conditions and qualities of a plea (which, as well as the doctrine of eſtoppels, will alſo hold equally, *mutatis mutandis*, with regard to other parts of pleading), are, 1. That it be ſingle and containing only one matter; for duplicity begets confuſion. But by ſtatute 4 and 5 Ann. c. 16. a man, with leave of the court, may plead two or more diſtinct matters or ſingle pleas; as in an action of aſſault and battery, theſe three, Not guilty, *ſon aſſault demeſne*, and the ſtatute of limitations. 2. That it be direct and poſitive, and not argumentative. 3. That it have convenient certainty of time, place, and perſons. 4. That it anſwer the plaintiff's allegations in every material point. 5. That it be ſo pleaded as to be capable of trial.

Special pleas are uſually in the affirmative, ſometimes in the negative, but they always advance ſome new fact not mentioned in the declaration; and then they muſt be averred to be true in the common form;—"And this he is ready to verify."—This is not neceſſary in pleas of the general iſſue, thoſe always containing a total denial of the facts before advanced by the other party, and therefore putting him upon the proof of them. See PLEADINGS.

PLEA *to Indictment*, the defenſive matter alleged by a criminal on his indictment: (ſee ARRAIGNMENT.) This is either, 1. A plea to the juriſdiction; 2. A demurrer; 3. A plea in abatement; 4. A ſpecial plea in bar; or, 5. The general iſſue.

I. A plea to the *juriſdiction*, is where an indictment is taken before a court that hath no cognizance of the offence; as if a man be indicted for a rape at the ſheriff's tourn, or for treaſon at the quarter-ſeſſions: in theſe or ſimilar caſes, he may except to the juriſdiction of the court, without anſwering at all to the crime alleged.

II. A *demurrer* to the indictment, is incident to criminal caſes, as well as civil, when the fact as alleged is allowed to be true, but the priſoner joins iſſue upon ſome point of law in the indictment by which he inſiſts, that the fact, as ſtated, is no felony, treaſon, or whatever the crime is alleged to be. Thus, for inſtance, if a man be indicted for feloniouſly ſtealing a greyhound; which is an animal in which no valuable property can be had, and therefore it is not felony, but only a civil treſpaſs to ſteal it; in this caſe the party indicted may demur to the indictment; denying it to be felony, tho' he confeſſes the act of taking it. Some have held, that if, on demurrer, the point of law be adjudged againſt the priſoner, he ſhall have judgment and execution, as if convicted by verdict. But this is denied by others, who hold, that in ſuch caſe he ſhall be directed and received to plead the general iſſue, Not guilty, after a demurrer determined againſt him. Which appears the more reaſonable, becauſe it is clear, that if the priſoner freely diſcovers the fact in court, and refers it to the opinion of the court whether it be felony or no; and upon the fact thus ſhown, it appears to be felony, the court will not record the confeſſion, but admit him afterwards to plead not guilty. And this ſeems to be a caſe of the ſame nature, being for the moſt part a miſtake in point of law, and in the conduct of his pleading; and, though a man by miſpleading may in ſome caſes loſe his property, yet the law will not ſuffer him by ſuch niceties to loſe his life. However, upon this doubt, demurrers to indictments are ſeldom uſed: ſince the ſame advantages may be taken upon a plea of not guilty; or afterwards, in arreſt of judgment, when the verdict has eſtabliſhed the fact.

III. A plea in *abatement* is principally for a *miſnomer*, a wrong name, or a falſe addition to the priſoner. As, if James Allen, gentleman, is indicted by the name of *John Allen, eſquire*, he may plead that he has the name of *James*, and not of *John*; and that he is a *gentleman*, and not an *eſquire*. And, if either fact is found by a jury, then the indictment ſhall be abated, as writs or declarations may be in civil actions. But, in the end, there is little advantage accruing to the priſoner by means of theſe dilatory pleas; becauſe, if the exception be allowed, a new bill of indictment may be framed, according to what the priſoner in his plea avers to be his true name and addition. For it is a rule, upon all pleas in abatement, that he who takes advantage of a flaw, muſt at the ſame time ſhow how it may be amended. Let us therefore next conſider a more ſubſtantial kind of plea, *viz.*

IV. Special pleas in *bar*; which go to the merits of the indictment, and give a reaſon why the priſoner ought not to anſwer it at all, nor put himſelf upon his trial for the crime alleged. Theſe are of four kinds; a former acquittal, a former conviction, a former attainder, or a pardon. There are many other pleas which may be pleaded in bar of an appeal: but theſe are applicable to both appeals and indictments.

1. Firſt, the plea of *auterfoits acquit*, or a former acquittal, is grounded on this univerſal maxim of the common law of England, that no man is to be brought into jeopardy of his life, more than once, for the ſame offence. And hence it is allowed as a conſequence, that when a man is once fairly found not guilty upon any indictment, or other proſecution, before any court having competent juriſdiction of the offence, he may plead ſuch acquittal in bar of any ſubſequent accuſation for the ſame crime.

2. Secondly, the plea of *auterfoits convict*, or a former conviction for the ſame identical crime, though no judgment was ever given, or perhaps will be (being ſuſpended by the benefit of clergy or other cauſes), is a good plea in bar to an indictment. And this depends upon the ſame principle as the former, that no man ought to be twice brought in danger of his life for one and the ſame crime.

Plea.

3. Thirdly, the plea of *auterfoits attaint*, or a former attainder, is a good plea in bar, whether it be for the fame or any other felony. For wherever a man is attainted of felony, by judgment of death either upon a verdict or confeffion, by outlawry, or heretofore by abjuration, and whether upon an appeal or an indictment; he may plead fuch attainder in bar to any fubfequent indictment or appeal, for the fame or for any other felony. And this becaufe, generally, fuch proceeding on a fecond profecution cannot be to any purpofe; for the prifoner is dead in law by the firft attainder, his blood is already corrupted, and he hath forfeited all that he had: fo that it is abfurd and fuperfluous to endeavour to attaint him a fecond time. Though to this general rule, as to all others, there are fome exceptions; wherein, *ceffante ratione, ceffat et ipfa lex.*

4. Laftly, a pardon may be pleaded in bar; as at once deftroying the end and purpofe of the indictment, by remitting that punifhment, which the profecution is calculated to inflict. There is one advantage that attends pleading a pardon in bar, or in arreft of judgment, before fentence is paft; which gives it by much the preference to pleading it after fentence or attainder. This is, that by ftopping the judgment it ftops the attainder, and prevents the corruption of the blood: which, when once corrupted by attainder, cannot afterwards be reftored otherwife than by act of parliament.

V. The *general iffue*, or plea of not guilty, upon which plea alone the prifoner can receive his final judgment of death. In cafe of an indictment of felony or treafon, there can be no fpecial juftification put in by way of plea. As, on an indictment for murder, a man cannot plead that it was in his own defence againft a robber on the highway, or a burglar; but he muft plead the general iffue, Not guilty, and give this fpecial matter in evidence. For (befides that thefe pleas do in effect amount to the general iffue; fince, if true, the prifoner is moft clearly not guilty) as the facts in treafon are laid to be done *proditorie et contra ligeantiæ fuæ debitum;* and, in felony, that the killing was done *felonice;* thefe charges, of a traiterous or felonious intent, are the points and very *gift* of the indictment, and muft be anfwered directly, by the general negative, Not guilty; and the jury upon the evidence will take notice of any defenfive matter, and give their verdict accordingly as effectually as if it were or could be fpecially pleaded. So that this is, upon all accounts, the moft advantageous plea for the prifoner.

When the prifoner hath thus pleaded not guilty, *non culpabilis*, or *nient culpable:* which was formerly ufed to be abbreviated upon the minutes, thus, *Non* (or *nient*) *cul.* the clerk of the affize, or clerk of arraigns, on behalf of the crown replies, that the prifoner is guilty, and that he is ready to prove him fo. This is done by two monofyllables in the fame fpirit of abbreviation, *cul. prit.*: which fignifies firft that the prifoner is guilty, (*cul. culpable*, or *culpabilis*); and then that the king is ready to prove him fo, (*prit, præfto fum*, or *paratus, verificare*). By this replication the king and the prifoner are therefore at iffue: for when the parties come to a fact which is affirmed on one fide and denied on the other, then they are faid to be at iffue in point of fact: which is evidently the cafe here, in the plea of *non cul.* by the prifoner; and the replication of *cul.* by the clerk.

How the courts came to exprefs a matter of this importance in fo odd and obfcure a manner, can hardly be pronounced with certainty. It may perhaps, however, be accounted for by fuppofing, that thefe were at firft fhort notes, to help the memory of the clerk, and remind him what he was to reply; or elfe it was the fhort method of taking down in court, upon the minutes, the replication and averment; *cul. prit:* which afterwards the ignorance of fucceeding clerks adopted for the very words to be by them fpoken (A).

But however it may have arifen, the joining of iffue feems to be clearly the meaning of this obfcure expreffion; which has puzzled our moft ingenious etymologifts, and is commonly underftood as if the clerk of the arraigns, immediately on plea pleaded, had fixed an opprobrious name on the prifoner, by afking him, "*culprit*, how wilt thou be tried?" for immediately upon iffue joined it is inquired of the prifoner, by what trial he will make his innocence appear. This form has at prefent reference to appeals and approvements only, wherein the appellee has his choice, either to try the accufation by BATTLE or by JURY. But upon indictments, fince the abolition of ORDEAL, there can be no other trial but by jury, *per pais*, or by the country: and therefore, if the prifoner refufes to put himfelf upon the inqueft in the ufual form, that is, to anfwer that he will be tried by God and the country, if a commoner; and, if a peer, by God and his peers; the indictment, if in treafon, is taken *pro confeffo;* and the prifoner, in cafes of felony, is judged to ftand mute, and, if he perfeveres in his obftinacy, fhall now be convicted of the felony.

When the prifoner has thus put himfelf upon his trial, the clerk anfwers in the humane language of the law, which always hopes that the party's innocence rather than his guilt may appear, "God fend thee a good deliverance." And then they proceed, as foon as conveniently may be, to the trial. See the article TRIAL.

Pleading.

PLEADINGS, in law, are the mutual altercations between the plaintiff and defendant, (fee SUIT, WRIT, and PROCESS). They form the third part or ftage of a fact; and at prefent are fet down and delivered into the proper office in writing, though formerly they were ufually put in by their council *ore tenus*, or *viva voce*, in court, and then minuted down by the chief clerks or prothonotaries; whence, in our old law-French, the pleadings are frequently denominated the *parol.*

The firft of thefe is the *declaration, narratio*, or *count*, anciently called the *tale;* in which the plaintiff fets forth his caufe of complaint at length: being indeed only an amplification

(A) Of this ignorance we may fee daily inftances, in the abufe of two legal terms of ancient French: one, the prologue to all proclamations, "*Oyez*, or Hear ye," which is generally pronounced, moft unmeaningly, "O yes:" the other, a more pardonable miftake, viz. when a jury are all fworn, the officer bids the crier number them, for which the word in law French is, "*Countez*;" but we now hear it pronounced in very good Englifh, "Count thefe."

Pleadings. Breach of Covenant.

amplification or expoſition of the original writ upon which his action is founded, with the additional circumſtances of time and place, when and where, the injury was committed.

In *local* actions, where poſſeſſion of land is to be recovered, or damages for an actual treſpaſs, or for waſte, &c. affecting land, the plaintiff muſt lay his declaration, or declare his injury to have happened in the very county and place that it really did happen; but in *tranſitory* actions, for injuries that might have happened anywhere, as debt, detinue, ſlander, and the like, the plaintiff may declare in what county he pleaſes, and then the trial muſt be in that county in which the declaration is laid. Though, if the defendant will make affidavit that the cauſe of action, if any, aroſe not in that but another county, the court will direct a change of *the venue* or *viſne* (that is, the *vicinia* or neighbourhood in which the injury is declared to be done), and will oblige the plaintiff to declare in the proper county. For the ſtatute 6 Ric. II. c. 2. having ordered all writs to be laid in their proper counties, this, as the judges conceived, impowered them to change the *venue*, if required, and not to inſiſt rigidly on abating the writ: which practice began in the reign of James I. And this power is diſcretionally exerciſed, ſo as not to cauſe but prevent a defect of juſtice. Therefore the court will not change the *venue* to any of the four northern counties previous to the ſpring circuit; becauſe there the aſſiſes are holden only once a-year, at the time of ſummer circuit. And it will ſometimes remove the *venue* from the proper juriſdiction (eſpecially of the narrow and limited kind), upon a ſuggeſtion, duly ſupported, that a fair and impartial trial cannot be had therein.

It is generally uſual, in actions upon the caſe, to ſet forth ſeveral caſes, by different counts in the ſame declaration; ſo that if the plaintiff fails in the proof of one, he may ſucceed in another. As in an action on the caſe upon an ASSUMPSIT for goods ſold and delivered, the plaintiff uſually counts or declares, firſt, upon a ſettled and agreed price between him and the defendant; as, that they bargained for 20l.: and leſt he ſhould fail in the proof of this, he counts likewiſe upon a *quantum valebant;* that the defendant bought other goods, and agreed to pay him ſo much as they were reaſonably worth: and then avers that they were worth other 20l. and ſo on in three or four different ſhapes; and at laſt concludes with declaring, that the defendant had refuſed to fulfil any of theſe agreements, whereby he is endamaged to ſuch a value. And if he proves the caſe laid in any one of his counts, though he fails in the reſt, he ſhall recover proportionable damages. This declaration always concludes with theſe words, "and thereupon he brings ſuit," &c. *inde producit ſectam, &c.* By which words, *ſuit* or *ſecta (a ſequendo)*, were anciently underſtood the witneſſes or followers of the plaintiff. For in former times, the law would not put the defendant to the trouble of anſwering the charge till the plaintiff had made out at leaſt a probable caſe. But the actual production of the *ſuit, ſecta,* or *followers*, is now antiquated, and hath been totally diſuſed, at leaſt ever ſince the reign of Edward III. though the form of it ſtill continues.

At the end of the declaration are added alſo the plaintiff's common pledges of proſecution, John Doe and Richard Roe; which, as we elſewhere obſerve, (ſee WRIT), are now mere names of form; though formerly they were of uſe to anſwer to the king for the amercement of the plaintiff, in caſe he were nonſuited, barred of his action, or had a verdict and judgment againſt him. For if the plaintiff neglects to deliver a declaration for two terms after the defendant appears, or is guilty of other delays or defaults againſt the rules of law in any ſubſequent ſtage of the action, he is adjudged not to follow or purſue his remedy as he ought to do; and thereupon a *nonſuit*, or *non proſequitur*, is entered, and he is ſaid to be *non-proſ'd*. And for thus deſerting his complaint, after making a falſe claim or complaint *(pro falſo clamore ſuo)*, he ſhall not only pay coſts to the defendant, but is liable to be amerced to the king. A *retraxit* differs from a nonſuit, in that the one is negative and the other poſitive: the nonſuit is a default and neglect of the plaintiff, and therefore he is allowed to begin his ſuit again upon payment of coſts; but a *retraxit* is an open and voluntary renunciation of his ſuit in court; and by this he for ever loſes his action. A *diſcontinuance* is ſomewhat ſimilar to a nonſuit; for when a plaintiff leaves a chaſm in the proceedings of his cauſe, as by not continuing the proceſs regularly from day to day, and time to time, as he ought to do, the ſuit is diſcontinued, and the defendant is no longer bound to attend; but the plaintiff muſt begin again, by ſuing out a new original, uſually paying coſts to his antagoniſt.

When the plaintiff hath ſtated his caſe in the declaration, it is incumbent on the defendant, within a reaſonable time, to make his defence, and to put in a plea; or elſe the plaintiff will at once recover judgment by *default*, or *nihil dicit*, of the defendant.

Defence, in its true legal ſenſe, ſignifies not a juſtification, protection, or guard, which is now its popular ſignification; but merely an *oppoſing* or *denial* (from the French verb *defendre)* of the truth or validity of the complaint. It is the *conteſtatio litis* of the civilians: a general aſſertion that the plaintiff hath no ground of action; which aſſertion is afterwards extended and maintained in his plea.

Before defence made, if at all, cognizance of the ſuit muſt be claimed or demanded; when any perſon or body-corporate hath the franchiſe, not only of holding pleas within a particular limited juriſdiction, but alſo of the cognizance of pleas; and that either without any words excluſive of other courts, which intitles the lord of the franchiſe, whenever any ſuit that belongs to his juriſdiction is commenced in the courts at Weſtminſter, to demand the cognizance thereof; or with ſuch excluſive words, which alſo intitle the defendant to plead to the juriſdiction of the court. Upon this claim of cognizance, if allowed, all proceedings ſhall ceaſe in the ſuperior court, and the plaintiff is left at liberty to purſue his remedy in the ſpecial juriſdiction. As, when a ſcholar or other privileged perſon of the univerſities of Oxford or Cambridge is impleaded in the courts at Weſtminſter, for any cauſe of action whatſoever, unleſs upon a queſtion of freehold. In theſe caſes, by the charter of thoſe learned bodies, confirmed by act of parliament, the chancellor, or vice-chancellor, may put in a claim of cognizance; which, if made in due time and form, and with due proof of the facts alleged, is regu-

larly

Pleadings.

Pleadings. larly allowed by the courts. It muſt be demanded before full defence is made or imparlance prayed; for theſe are a ſubmiſſion to the juriſdiction of the ſuperior court, and the delay is a *laches* in the lord of the franchiſe: and it will not be allowed if it occaſions a failure of juſtice, or if an action be brought againſt the perſon himſelf who claims the franchiſe, unleſs he hath alſo a power in ſuch caſe of making another judge.

After defence made, the defendant muſt put in his plea. But before he defends, if the ſuit is commenced by *capias* or *latitat*, without any ſpecial original, he is intitled to demand one *imparlance*, or *licentia loquendi;* and may, before he pleads, have more granted by conſent of the court, to ſee if he can end the matter amicably without farther ſuit, by talking with the plaintiff: a practice which is ſuppoſed to have ariſen from a principle of religion, in obedience to that precept of the goſpel, "agree with thine adverſary quickly, whilſt thou art *in the way* with him." And it may be obſerved, that this goſpel-precept has a plain reference to the Roman law of the twelve tables, which expreſsly directed the plaintiff and defendant to make up the matter while they were in the way, or going to the prætor;—*in via, rem uti pacent orato*. There are alſo many other previous ſteps which may be taken by a defendant before he puts in his plea. He may, in real actions, demand a view of the thing in queſtion, in order to aſcertain its identity and other circumſtances. He may crave *oyer* of the writ, or of the bond, or other ſpecialty upon which the action is brought; that is, to hear it read to him; the generality of defendants in the times of ancient ſimplicity being ſuppoſed incapable to read it themſelves: whereupon the whole is entered *verbatim* upon the record; and the defendant may take advantage of any condition, or other part of it, not ſtated in the plaintiff's declaration. In real actions alſo the tenant may pray in *aid*, or call for the aſſiſtance of another, to help him to plead, becauſe of the feebleneſs or imbecility of his own eſtate. Thus a tenant for life may pray in aid of him that hath the inheritance in remainder or reverſion; and an incumbent may pray in aid of the patron and ordinary; that is, that they ſhall be joined in the action, and help to defend the title. *Voucher* alſo is the calling in of ſome perſon to anſwer the action, that hath warranted the title to the tenant or defendant. This we ſtill make uſe of in the form of common recoveries, which are grounded on a writ of entry; a ſpecies of action that relies chiefly on the weakneſs of the tenant's title, who therefore vouches another perſon to warrant it. If the vouchee appears, he is made defendant inſtead of the voucher; but if he afterwards makes default, recovery ſhall be had againſt the original defendant; and he ſhall recover an equivalent in value againſt the deficient vouchee. In aſſizes, indeed, where the principal queſtion is, whether the demandant or his anceſtors were or were not in poſſeſſion till the ouſter happened, and the title of the tenant is little (if at all) diſcuſſed, there no voucher is allowed; but the tenant may bring a writ of *warrantia chartæ* againſt the warrantor, to compel him to aſſiſt him with a good plea or defence, or elſe to render damages and the value of the land, if recovered againſt the tenant. In many real actions alſo, brought by or againſt an infant under the age of 21 years, and alſo in actions of debt brought againſt him, as heir to any deceaſed anceſtor, either party may ſuggeſt the nonage of the infant, and pray that the proceedings may be deferred till his full age, or, in our legal phraſe, that the infant may have his age, and that the *parol may demur*, that is, that the pleadings may be ſtaid; and then they ſhall not proceed till his full age, unleſs it be apparent that he cannot be prejudiced thereby. But by the ſtatutes of Weſtm. 1. 3 Edw. I. c. 46. and of Gloceſter, 6 Edw. I. c. 2. in writs of entry *ſur diſſeiſin* in ſome particular caſes, and in actions aunceſtrel brought by an infant, the parol ſhall not demur; otherwiſe he might be deforced of his whole property, and even want a maintenance, till he came of age. So likewiſe in a writ of dower the heir ſhall not have his age; for it is neceſſary that the widow's claim be immediately determined, elſe ſhe may want a preſent ſubſiſtence. Nor ſhall an infant patron have it in a *quare impedit*, ſince the law holds it neceſſary and expedient that the church be immediately filled.

When theſe proceedings are over, the defendant muſt then put in his excuſe or plea. See Plea.

It is a rule in pleading, that no man be allowed to plead ſpecially ſuch a plea as amounts only to the general iſſue, or a total denial of the charge; but in ſuch caſe he ſhall be driven to plead the general iſſue in terms, whereby the whole queſtion is referred to a jury. But if the defendant, in an aſſize or action of treſpaſs, be deſirous to refer the validity of his title to the court rather than the jury, he may ſtate his title ſpecially; and at the ſame time give colour to the plaintiff, or ſuppoſe him to have an appearance or colour of title, bad indeed in point of law, but of which the jury are not competent judges. As if his own true title is, that he claims by feoffment with livery from A, by force of which he entered on the lands in queſtion, he cannot plead this by itſelf, as it amounts to no more than the general iſſue, *nul tort, nul diſſeiſin*, in aſſize, or *not guilty* in an action of treſpaſs. But he may allege this ſpecially, provided he goes farther, and ſays, that the plaintiff claiming by colour of a prior deed of feoffment, without livery, entered; upon whom he entered; and may then refer himſelf to the judgment of the court which of theſe two titles is the beſt in point of law.

When the plea of the defendant is thus put in, if it does not amount to an iſſue or total contradiction of the declaration, but only evades it, the plaintiff may plead again, and reply to the defendant's plea: Either traverſing it, that is, totally denying it; as if, on an action of debt upon bond, the defendant pleads *ſolvit ad diem*, that he paid the money when due; here the plaintiff in his replication may totally traverſe this plea, by denying that the defendant paid it: Or he may allege new matter in contradiction to the defendant's plea; as when the defendant pleads no award made, the plaintiff may reply, and ſet forth an actual award, and aſſign a breach: Or the replication may confeſs and avoid the plea, by ſome new matter or diſtinction, conſiſtent with the plaintiff's former declaration; as in an action for treſpaſſing upon land whereof the plaintiff is ſeized, if the defendant ſhows a title to the land by deſcent, and that therefore he had a right to enter, and gives colour to the plaintiff, the plaintiff may either traverſe and totally deny the fact of the deſcent; or he may confeſs and avoid it, by replying, that true it is that ſuch deſcent

Pleadings. scent happened, but that since the descent the defendant himself demised the lands to the plaintiff for term of life. To the replication the defendant may *rejoin*, or put in an answer called a *rejoinder*. The plaintiff may answer the rejoinder by a *sur-rejoinder*; upon which the defendant may *rebut*, and the plaintiff answer him by a *sur-rebutter*. Which pleas, replications, rejoinders, sur-rejoinders, rebutters, and sur-rebutters, answer to the *exceptio*, *replicatio*, *duplicatio*, *triplicatio*, and *quadruplicatio*, of the Roman laws.

The whole of this process is denominated the *pleading*; in the several stages of which it must be carefully observed, not to depart or vary from the title or defence which the party has once insisted on. For this (which is called a *departure* in pleading) might occasion endless altercation. Therefore the replication must support the declaration, and the rejoinder must support the plea, without departing out of it. As in the case of pleading no award made in consequence of a bond of arbitration, to which the plaintiff replies, setting forth an actual award; now the defendant cannot rejoin that he hath performed this award, for such rejoinder would be an entire departure from his original plea, which alleged that no such award was made: therefore he has now no other choice, but to traverse the fact of the replication, or else to demur upon the law of it.

Again, all duplicity in pleading must be avoided. Every plea must be simple, entire, connected, and confined to one single point: it must never be entangled with a variety of distinct independent answers to the same matter; which must require as many different replies, and introduce a multitude of issues upon one and the same dispute. For this would often embarrass the jury, and sometimes the court itself, and at all events would greatly enhance the expence of the parties. Yet it frequently is expedient to plead in such a manner as to avoid any implied admission of a fact, which cannot with propriety or safety be positively affirmed or denied. And this may be done by what is called a *protestation*; whereby the party interposes an oblique allegation or denial of some fact, protesting (by the gerund, *protestando*) that such a matter does or does not exist; and at the same time avoiding a direct affirmation or denial. Sir Edward Coke hath defined a protestation (in the pithy dialect of that age) to be, "an exclusion of a conclusion." For the use of it is, to save the party from being concluded with respect to some fact or circumstance which cannot be directly affirmed or denied without falling into duplicity of pleading; and which yet, if he did not thus enter his protest, he might be deemed to have tacitly waved or admitted. Thus, while tenure in villainage subsisted, if a villain had brought an action against his lord, and the lord was inclined to try the merits of the demand, and at the same time to prevent any conclusion against himself that he had waved his signiory; he could not in this case both plead affirmatively that the plaintiff was his villain, and also take issue upon the demand; for then his plea would have been double, as the former alone would have been a good bar to the action: but he might have alleged the villainage of the plaintiff by way of protestation, and then have denied the demand. By this means the future vassalage of the plaintiff was saved to the defendant, in case the issue was found in his (the defendant's) favour; for the protestation prevented that conclusion which would otherwise have resulted from the rest of his defence, that he had enfranchised the plaintiff, since no villain could maintain a civil action against his lord. So also if a defendant, by way of inducement to the point of his defence, alleges (among other matters) a particular mode of seisin or tenure which the plaintiff is unwilling to admit, and yet desires to take issue on the principal point of the defence, he must deny the seisin or tenure by way of protestation, and then traverse the defensive matter. So, lastly, if an award be set forth by the plaintiff, and he can assign a breach in one part of it (viz. the non-payment of a sum of money), and yet is afraid to admit the performance of the rest of the award, or to aver in general a non-performance of any part of it, lest something should appear to have been performed; he may save to himself any advantage he might hereafter make of the general non-performance, by alleging that by protestation, he can plead only the non-payment of the money.

In any stage of the pleadings, when either side advances or affirms any new matter, he usually (as was said) avers it to be true; "and this he is ready to verify." On the other hand, when either side traverses or denies the facts pleaded by his antagonist, he usually tenders an *issue*, as it is called; the language of which is different according to the party by whom it is tendered: for if the traverse or denial comes from the defendant, the issue is tendered in this manner, "And of this he puts himself upon the country," thereby submitting himself to the judgment of his peers: but if the traverse lies upon the plaintiff, he tenders the issue or prays the judgment of the peers against the defendant in another form; thus, "and this he prays may be inquired of by the country."

But if either side (as, for instance, the defendant) pleads a special negative plea, not traversing or denying any thing that was before alleged, but disclosing some new negative matter; as where the suit is on a bond conditioned to perform an award, and the defendant pleads, negatively, that no award was made; he tenders no issue upon this plea, because it does not yet appear whether the fact will be disputed, the plaintiff not having yet asserted the existence of any award: but when the plaintiff replies, and sets forth an actual specific award, if then the defendant traverses the replication, and denies the making of any such award, he then, and not before, tenders an issue to the plaintiff. For when in the course of pleading they come to a point which is affirmed on one side and denied on the other, they are then said to be at issue; all their debates being at last contracted into a single point, which must now be determined either in favour of the plaintiff or of the defendant. See ISSUE.

Pleadings ‖ Pleasure.

PLEASING, art of. See POLITENESS.

PLEASURE is a word so universally understood as to need no explanation. Lexicographers, however, who must attempt to explain every word, call it "the gratification of the mind or senses." It is directly opposite to PAIN, and constitutes the whole of positive happiness as that does of misery.

The Author of Nature has furnished us with many pleasures, as well as made us liable to many pains; and we are susceptible of both in some degree as soon as we have life and are endowed with the faculty of sensation. A French writer, in a work* which once raised high expectations

* *Encyclopédie Methodique, Logique, Metaphysique, et Morale*, tom. 4.

Pleasure. expectations, contends, that a child in the womb of its mother feels neither pleasure nor pain. "These sensations (says he) are not innate; they have their origin from without: and it is at the moment of our birth that the soul receives the first impressions; impressions slight and superficial at the beginning, but which by time and repeated acts leave deeper traces in the sensorium, and become more extensive and more lasting. It is when the child sends forth its first cries that sensibility or the faculty of sensation is produced, which in a short time gathers strength and stability by the impression of exterior objects. Pleasure and pain not being innate, and being only acquired in the same manner as the qualities which we derive from instruction, education, and society, it follows that we learn to suffer and enjoy as we learn any other science."

This is strange reasoning and strange language. That sensations are not innate is universally acknowledged; but it does not therefore follow that the soul receives its first impressions and first sensations at the moment of birth. The child has life, the power of locomotion, and the sense of touch, long before it is born; and every mother will tell this philosopher, that an infant unborn exhibits symptoms both of pain and of pleasure. That many of our organs of sense are improved by use is incontrovertible; but it is so far from being true that our sensible pleasures become more exquisite by being often repeated, that the direct contrary is experienced of far the greater part of them; and though external objects, by making repeated impressions on the senses, certainly leave deeper traces on the memory than an object once perceived can do, it by no means follows that these impressions become the more delightful the more familiar that they are to us. That we learn to suffer and enjoy as we learn any other science, is a most extravagant paradox; for it is self-evident that we cannot live without being capable in some degree both of suffering and enjoyment, though a man may certainly live to old age in profound ignorance of all the sciences.

The same writer assures us, indeed, that sensation is not necessary to human life. "Philosophers (says he) make mention of a man who had lost every kind of feeling in every member of his body: he was pinched or pricked to no purpose. Meanwhile this man made use of all his members; he walked without pain, he drank, ate, and slept, without perceiving that he did so. Sensible neither to pleasure nor pain, he was a true natural machine."

To the tale of these anonymous philosophers our author gives implicit credit, whilst he favours us at the same instant with the following argumentation, which completely proves its falsehood. "It is true that sensation is a relative quality, susceptible of increase and diminution; that it is not necessary to existence; and that one might live without it: but in this case he would live as an automaton, without feeling pleasure or pain; and he would possess neither idea, nor reflection, nor desire, nor passion, nor will, nor sentiment; his existence would be merely passive, he would live without knowing it, and die without apprehension."

But if this man of the philosophers, whom our author calls an *automaton*, and a *true natural machine*, had neither *idea*, nor *desire*, nor *passion*, nor *will*, nor *sentiment* (and without sensation he certainly could have none of them), what induced him to *walk*, *eat*, or *drink*, or to *cease* from any of these operations after they were accidentally begun? The instances of the *automata* which played on the flute and at chess are not to the purpose for which they are adduced; for there is no parallel between them and this natural machine, unless the philosophers wound up their man to eat, drink, walk, or sit, as Vacanson and Kempeler wound up their automata to play or cease from playing on the German flute and at chess. See Androides. Pleasure.

Our author having for a while sported with these harmless paradoxes, proceeds to put the credulity of his reader to the test with others of a very contrary tendency. He institutes an inquiry concerning the superiority, in number and degree, of the pleasures enjoyed by the different orders of men in society; and labours, not indeed by argument, but by loose declamation, to propagate the belief that happiness is very unequally distributed. The pleasures of the rich, he says, must be more numerous and exquisite than those of the poor; the nobleman must have more enjoyments than the plebeian of equal wealth; and the king, according to him, must be the happiest of all men. He owns, indeed, that although "birth, rank, honours, and dignity, add to happiness, a man is not to be considered as miserable because he is born in the lower conditions of life. A man may be happy as a mechanic, a merchant, or a labourer, provided he enters into the spirit of his profession, and has not imbibed by a misplaced education those sentiments which make his condition insupportable. Happiness is of easy acquisition in the middling stations of life; and though perhaps we are unable to know or to rate exactly the pleasure which arises from contentment and mediocrity, yet happiness being a kind of aggregate of delights, of riches, and of advantages more or less great, every person must have a share of it; the division is not exactly made, but all other things equal, there will be more in the elevated than in the inferior conditions of society; the enjoyment will be more felt, the means of enjoying more multiplied, and the pleasures more varied. Birth, rank, fortune, talents, wit, genius, and virtue, are then the great sources of happiness: those advantages are so considerable, that we see men contented with any one of them, but their union forms supreme felicity.

"There is so vast a difference, says Voltaire, between a man who has made his fortune and one who has to make it, that they are scarcely to be considered as creatures of the same kind. The same thing may be said of birth, the greatest of all advantages in a large society; of rank, of honours, and of great abilities. How great a difference is made between a person of high birth and a tradesman; between a Newton or Descartes and a simple mathematician? Ten thousand soldiers are killed on the field of battle, and it is scarcely mentioned; but if the general falls, and especially if he be a man of courage and abilities, the court and city are filled with the news of his death, and the mourning is universal.

"Frederic the Great, the late king of Prussia, felt in a more lively manner than perhaps any other man the value of great talents. I would willingly renounce, said he to Voltaire, every thing which is an object of desire and ambition to man; but I am certain if I were not

Pleasure. not a prince I should be nothing. Your merit alone would gain you the esteem, and envy, and admiration of the world; but to secure respect for me, titles, and armies, and revenues, are absolutely necessary."

For what purpose this account of human happiness was published, it becomes not us to say. Its obvious tendency is to make the lower orders of society discontented with their state, and envious of their superiors; and it is not unreasonable to suppose, that it contributed in some degree to excite the ignorant part of the author's countrymen to the commission of those atrocities of which they have since been guilty. That such was his intention, the following extract will not permit us to believe; for though in it the author attempts to support the same false theory of human happiness, he mentions virtuous kings with the respect becoming a loyal subject of the unfortunate Louis, whose character he seems to have intentionally drawn, and whose death by the authority of a savage faction he has in effect foretold.

"Happiness, in a state of society, takes the most variable forms: it is a Proteus susceptible of every kind of metamorphosis: it is different in different men, in different ages, and in different conditions, &c. The pleasures of youth are very different from those of old age: what affords enjoyment to a mechanic would be supreme misery to a nobleman; and the amusements of the country would appear insipid in the capital. Is there then nothing fixed with regard to happiness? Is it of all things the most variable and the most arbitrary? Or, in judging of it, is it impossible to find a standard by which we can determine the limits of the greatest good to which man can arrive in the present state? It is evident that men form the same ideas of the beautiful and sublime in nature, and of right and wrong in morality, provided they have arrived at that degree of improvement and civilization of which human nature is susceptible; and that different opinions on these subjects depend on different degrees of culture, of education, and of improvement. The same thing may be advanced with regard to happiness: all men, if equal with respect to their organs, would form the very same ideas on this subject if they reached the degree of improvement of which we are presently speaking; and in fact, do we not see in the great circles at Rome, at Vienna, at London, and Paris, that those who are called people of fashion, who have received the same education, have nearly the same taste, the same desires, and the same spirit for enjoyment? there is doubtless a certain degree of happiness to be enjoyed in every condition of life; but as there are some conditions preferable to others, so are there degrees of happiness greater and less; and if we were to form an idea of the greatest possible in the present state, it perhaps would be that of a sovereign, master of a great empire, enjoying good health and a moderate spirit; endowed with piety and virtue, whose whole life was employed in acts of justice and mercy, and who governed by fixed and immoveable laws. Such a king is the image of the divinity on earth, and he must be the idol of a wise people. His whole life should present a picture of the most august felicity. Although such sovereigns are rare, yet we are not without examples of them. Ancient history affords us Titus and Marcus Aurelius, and the present age can boast of piety and munificence in the character of some of its kings. This state of the greatest happiness to which man can reach not being ideal, it will serve as a standard of comparison by which happiness and misery can be estimated in all civilized countries. *He is as happy as a king*, is a proverbial expression, because we believe with justice that royalty is the extreme limit of the greatest enjoyments; and in fact, happiness being the work of man, that condition which comprehends all the degrees of power and of glory, which is the source of honour and of dignity, and which supposes in the person invested with it all means of enjoyment either for himself or others, leaves nothing on this earth to which any reasonable man would give the preference.

"We can find also in this high rank the extreme of the greatest evils to which the condition of nature is exposed. A king condemned to death, and perishing on a scaffold, by the authority of a faction, while at the same time he had endeavoured by every means in his power to promote the general happiness of his subjects, is the most terrible and striking example of human misery; for if it be true that a crown is the greatest of all blessings, then the loss of it, and at the same time the loss of life by an ignominious and unjust sentence, are of all calamities the most dreadful.

"It is also in the courts of kings that we find the most amiable and perfect characters; and it is there where true grandeur, true politeness, the best tone of manners, the most amiable graces, and the most eminent virtues, are completely established. It is in courts that men seem to have acquired their greatest improvement: Whosoever has seen a court, says La Bruyere, has seen the world in the most beautiful, the most enchanting, and attractive colours. The prejudices of mankind in behalf of the great are so excessive, that if they inclined to be good they would be almost the objects of adoration."

In this passage there are doubtless many just observations; but there is at least an equal number of others both false and dangerous. That a crown is the greatest of earthly blessings, and that it is in the courts of kings that we meet with the most amiable and perfect characters, are positions which a true philosopher will not admit but with great limitations. The falsehood of the author's general theory respecting the unequal distribution of happiness in society, we need not waste time in exposing. It is sufficiently exposed in other articles of this work, and in one of them by a writer of a very superior order (See HAPPINESS; and *MORAL Philosophy*, Part II. chap. ii.) He enters upon other speculations respecting the pleasures and pains of savages, which are ingenious and worthy of attention; but before we proceed to notice them, it will be proper to consider the connection which subsists between pleasure and pain.

"That the cessation of pain is accompanied by pleasure, is a fact (says a philosopher of the first rank †) which has been repeatedly observed, but perhaps not sufficiently accounted for. Let us suppose a person in a state of indifference as to heat. Upon coming near a fire, he will experience at first an agreeable warmth, *i. e.* pleasure. If the heat be increased, this state of pleasure will, after a time, be converted into one of pain, from the increased action upon the nerves and brain,

† Dr Sayers.

Pleasure.

brain, the undoubted organs of all bodily ſenſations. Let the heat now be gradually withdrawn, the nervous ſyſtem muſt acquire again, during this removal, the ſtate of agreeable warmth or pleaſure; and after paſſing through that ſtate it will arrive at indifference. From this fact then we may conclude, that a ſtate of pleaſure may be puſhed on till it is converted into one of pain; and, on the other hand, that an action which produces pain will, if it go off gradually, induce at a certain period of its decreaſe a ſtate of pleaſure. The ſame reaſoning which has thus been applied to the body may be extended alſo to the mind. Total languor of mind is not ſo pleaſant as a certain degree of action or emotion; and emotions pleaſant at one period may be increaſed till they become painful at another; whilſt painful emotions, as they gradually expire, will, at a certain period of their decreaſe, induce a ſtate of pleaſure. Hence then we are able to explain why pleaſure ſhould ariſe in all caſes from the gradual ceſſation of any action or emotion which produces pain."

The ſame author maintains, that from the mere removal of pain, whether by degrees or inſtantaneouſly, we always experience pleaſure; and if the pain removed was exquiſite, what he maintains is certainly true. To account for this phenomenon he lays down the following law of nature, which experience abundantly confirms, *viz.* "that the temporary withdrawing of any action from the body or mind invariably renders them more ſuſceptible of that action when again produced." Thus, after long faſting, the body is more ſuſceptible of the effects of food than if the ſtomach had been lately ſatisfied; the action of ſtrong liquors is found to be greater on thoſe who uſe them ſeldom than on ſuch as are in the habit of drinking them. Thus, too, with reſpect to the mind; if a perſon be deprived for a time of his friend's ſociety, or of a favourite amuſement, the next viſit of his friend, or the next renewal of his amuſement, is attended with much more pleaſure than if they had never been withheld from him.

"To apply this law to the caſe of a perſon ſuddenly relieved from acute pain. While he labours with ſuch pain, his mind is ſo totally occupied by it, that he is unable to attend to his cuſtomary purſuits or amuſements. He becomes therefore ſo much more ſuſceptible of their action, that when they are again preſented to him, he is raiſed above his uſual indifference to poſitive pleaſure. But all pains do not proceed from an exceſs of action. Many of them ariſe from reducing the body or the mind to a ſtate below indifference. Thus, if a perſon have juſt ſufficient warmth in his body to keep him barely at eaſe or in a ſtate of indifference, by withdrawing this heat a ſtate of uneaſineſs or pain is produced; and if in a calm ſtate of mind one be made acquainted with a melancholy event, his quiet is interrupted, and he ſinks below indifference into a painful ſtate of mind. If now, without communicating any new ſource of poſitive pleaſure, we remove in the former caſe the cold, and in the latter the grief, the perſons from whom they are removed will experience real pleaſure. Thus, then, whether pain ariſes from exceſs or deficiency of action, the gradual or the ſudden removal of it muſt be in all caſes attended with pleaſure‡." It is equally true that the gradual or ſudden removal of pleaſure is attended with pain.

‡ *Diſquiſitions Metaphyſical and Literary.*

We are now prepared to examine our French author's account of the pleaſures and pains of ſavages. "Every age (ſays he) has its different pleaſures; but if we were to imagine that thoſe of childhood are equal to thoſe of confirmed age, we ſhould be much miſtaken in our eſtimation of happineſs. The pleaſures of philoſophy, either natural or moral, are not unfolded to the infant; the moſt perfect muſic is a vain noiſe; the moſt exquiſite perfumes and diſhes highly ſeaſoned offend his young organs inſtead of affording delight; his touch is imperfect; forty days elapſe before the child gives any ſign of laughter or of weeping; his cries and groans before that period are not accompanied with tears; his countenance expreſſes no paſſion; the parts of his face bear no relation to the ſentiments of the ſoul, and are moreover without conſiſtency. Children are but little affected with cold; whether it be that they feel leſs, or that the interior heat is greater than in adults. In them all the impreſſions of pleaſure and pain are tranſitory; their memory has ſcarcely begun to unfold its powers; they enjoy nothing but the preſent moment; they weep, laugh, and give tones of ſatisfaction without conſciouſneſs, or at leaſt without reflection; their joy is confined to the indulgence of their little whims, and conſtraint is the greateſt of their misfortunes; few things amuſe, and nothing ſatisfies them. In this happy condition of early infancy nature is at the whole expence of happineſs; and the only point is not to contradict her. What deſires have children? Give them liberty in all their movements, and they have a plenitude of exiſtence, an abundance of that kind of happineſs which is confined in ſome ſort to all the objects which ſurround them: but if all beings were happy on the ſame conditions, ſociety would be at no expence in procuring the happineſs of the different individuals who compoſe it. Senſation is the foundation of reflection; it is the principal attribute of the ſoul; it is by this that man is elevated to ſublime ſpeculations, and ſecures his dominion over nature and himſelf. This quality is not ſtationary, but ſuſceptible, like all other relative qualities, of increaſe and decay, of different degrees of ſtrength and intenſeneſs: it is different in different men; and in the ſame man it increaſes from infancy to youth, from youth to confirmed manhood: at this period it ſtops, and gradually declines as we proceed to old age and to ſecond childiſhneſs. Conſidered phyſically, it varies according to age, conſtitution, climate, and food; conſidered in a moral point of view, it takes its different appearances from individual education, and from the habits of ſociety; for man in a ſtate of nature and ſociety, with regard to ſenſation and the unfolding of his powers, may be conſidered as two diſtinct beings: and if one were to make a calculation of pleaſure in the courſe of human life, a man of fortune and capacity enjoys more than ten thouſand ſavages.

"Pleaſure and pain being relative qualities, they may be almoſt annihilated in the moment of vehement paſſion. In the heat of battle, for example, ardent and animated ſpirits have not felt the pain of their wounds; and minds ſtrongly penetrated with ſentiments of religion, enthuſiaſm, and humanity, have ſupported the moſt cruel torments with courage and fortitude. The ſenſibility of ſome perſons is ſo exquiſitely alive, that one can ſcarcely approach them without throwing them into convulſions. Many diſeaſes ſhow the effect of ſenſibility puſhed to an extreme; ſuch as hyſteric affections,

certain

Pleasure. certain kinds of madness, and some of those which proceed from poison, and from the bite or sting of certain animals, as the viper and the tarantula. Excessive joy or grief, fear and terror, have been known to destroy all sensation, and occasion death (A)"

Having made these preliminary observations on pleasure and pain in infancy, and as they are increased or diminished by education, and the different conditions of body and mind, our author proceeds to consider the capability of savages to feel pleasure and pain. "By savages he understands all the tribes of men who live by hunting and fishing, and on those things which the earth yields without cultivation. Those tribes who possess herds of cattle, and who derive their subsistence from such possessions, are not to be considered as savages, as they have some idea of property. Some savages are naturally compassionate and humane, others are cruel and sanguinary. Although the physical constitution of man be everywhere the same, yet the varieties of climate, the abundance or scarcity of natural productions, have a powerful influence to determine the inclinations. Even the fierceness of the tyger is softened under a mild sky; now nature forms the manners of savages just as society and civil institutions form the manners of civilized life. In the one case climate and food produce almost the whole effect; in the other they have scarcely any influence. The habits of society every moment contend with nature, and they are almost always victorious. The savage devotes himself to the dominion of his passions; the civilized man is employed in restraining, in directing, and in modifying them: so much influence have government, laws, society, and the fear of censure and punishment, over his soul.

"It is not to be doubted that savages are susceptible both of pleasure and pain; but are the impressions made on their organs as sensible, or do they feel pain in the same degree with the inhabitants of a civilized country?

"Their enjoyments are so limited, that if we confine ourselves to truth, a few lines will be sufficient to describe them: our attention must therefore be confined to pain, because the manner in which they support misfortune, and even torture, presents us with a view of character unequalled in the history of civilized nations. It is not uncommon in civilized countries to see men braving death, meeting it with cheerfulness, and even not uttering complaints under the torture; but they do not insult the executioners of public vengeance, and defy pain in order to augment their torments; and those who are condemned by the laws suffer the punishment with different degrees of fortitude. On those mournful occasions, the common ranks of mankind in general die with less firmness: those, on the other hand, who have received education, and who, by a train of unfortunate events, are brought to the scaffold, whether it be the fear of being reproached with cowardice, or the consideration that the stroke is inevitable, such men discover the expiring sighs of self-love even in their last moments; and those especially of high rank, from their manners and sentiments, are expected to meet death with magnanimity: but an American savage in the moment of punishment appears to be more than human; he is a hero of the first order who braves his tormentors, who provokes them to employ all their art, and who considers as his chief glory to bear the greatest degree of pain without shrinking (See AMERICA, n° 14, 27, 28, 29). The recital of their tortures would appear exaggerated, if it were not attested by the best authority, and if the savage nations among whom those customs are established were not sufficiently known; but the excess of the cruelty is not so astonishing as the courage of the victim. The European exposed to sufferings of the same dreadful nature would rend heaven and earth with his piercing cries and horrible groans; the reward of martyrdom, the prospect of eternal life, could alone give him fortitude to endure such torments; but the savage is not animated with this exalted hope. What supports him then in scenes of so exquisite suffering? The feeling of shame, the fear of bringing reproach on his tribe, and giving a stain to his fellows never to be wiped away, are the only sentiments which influence the mind of a savage, and which always, present to his imagination, animate him, support him, and lend him spirit and resolution. At the same time, however powerful those motives may be, they would not be alone sufficient, if the savage felt pain in the same degree with the European. Sensibility, as we have already observed, is increased by education; it is influenced by society, manners, laws, and government; climate and food work it into a hundred different shapes; and all the physical and moral causes contribute to increase and diminish it. The habitual existence of a savage would be a state of suffering to an inhabitant of Europe. You must cut the flesh of the one and tear it away with your nails, before you can make him feel in an equal degree to a scratch or prick of a needle in the other. The savage, doubtless, suffers under torture, but he suffers much less than an European in the same circumstances: the reason is obvious; the air which the savages breathe is loaded with fog and moist vapours; their rivers not being confined by high banks, are by the winds as well as in floods spread over the level fields, and deposite on them a putrid and pernicious slime; the trees squeezed one upon another, in that rude uncultivated country serve rather as a covering to the earth than an ornament. Instead of those fresh and delicious shades, those openings in the woods, and walks crossing each

(A) There are instances of persons who have died at the noise of thunder without being touched. A man frighted with the fall of a gallery in which he happened to be, was immediately seized with the black jaundice. M. le Cat mentions a young person on whom the insolence of another made such an impression, that his countenance became at first yellow, and then changed into black, in such a manner that in less than eight days he appeared to wear a mask of black velvet: he continued in this state for four months without any other symptom of bad health or any pain. A sailor was so terrified in a storm, that his face sweated blood, which like ordinary sweat returned as it was wiped off. Stahl, whose testimony cannot be called in question, cites a similar case of a girl who had been frightened with soldiers. The excess of fear, according to many physicians, produces madness and epilepsy.

Pleasure.

each other in all directions, which delight the traveller in the fine forests of France and Germany; those in America serve only to intercept the rays of the sun, and to prevent the benign influence of his beams. The savage participates of this cold humidity; his blood has little heat, his humours are gross, and his constitution phlegmatic. To the powerful influence of climate, it is necessary to join the habits of his life. Obliged to traverse vast deserts for subsistence, his body is accustomed to fatigue; food not nourishing, and at the same time in no great plenty, blunts his feelings; and all the hardships of the savage state give a rigidity to his members which makes him almost incapable of suffering. The savage in this state of nature may be compared to our water-women and street-porters, who, though they possess neither great vigour nor strength, are capable of performing daily, and without complaint, that kind of labour which to a man in a different condition of life would be a painful and grievous burden. Feeling, in less perfection with the savage, by the effects of climate and food, and the habits of his life, is still farther restrained by moral considerations. The European is less a man of nature than of society: moral restraints are powerful with him; while over the American they have scarcely any influence. This latter then is in a double condition of imperfection with regard to us; his senses are blunted, and his moral powers are not disclosed. Now, pleasure and pain depending on the perfection of the senses and the unfolding of the intellectual faculties, it cannot be doubted, that in enjoyments of any kind savages experience less pleasure, and in their suffering less pain, than Europeans in the same circumstances. And in fact, the savages of America possess a very feeble constitution. They are agile without being strong; and this agility depends more on their habits than on the perfection of their members: they owe it to the necessity of hunting; and they are moreover so weak, that they were unable to bear the toil which their first oppressors imposed on them. Hence a race of men in all respects so imperfect could not endure torment under which the most robust European would sink, if the pain which they feel were really as great as it appears to be. Feeling is then, and must necessarily be, less in the savage condition; for this faculty disclosing itself by the exercise of all the physical and moral qualities, must be less as they are less exercised. Every thing shows the imperfection of this precious quality, this source of all our affections, in the American savages.

"All the improvements in Europe have had a tendency to unfold sensibility: the air is purified that we may breathe more freely; the morasses are drained, the rivers are regulated in their courses, the food is nourishing, and the houses commodious. With the savages, on the contrary, every thing tends to curb it; they take pleasure even in hardening the organs of the body, in accustoming themselves to bear by degrees the most acute pain without complaining. Boys and girls among the savages amuse themselves with tying their naked arms together, and laying a kindled coal between them, to try which of them can longest suffer the heat; and the warriors who aspire to the honour of being chief, undergo a course of suffering which exceeds the idea of torture inflicted on the greatest criminals in Europe."

These observations on the pleasures and pains of savages appear to be well-founded, and, as the attentive reader will perceive, are perfectly agreeable to the theory of Dr Sayers. If indeed that theory be just, as we believe it to be, it will follow, that the few pleasures of sense which the American enjoys, he ought to enjoy more completely than any European, because to him they recur but seldom. This may very possibly be the case; and certainly would be so, were not his fibres, by climate and the habits of his life, rendered more rigid than those of the civilized part of the inhabitants of Europe. But if we agree with our author§ in what he says of the pains and pleasures of savages, we cannot admit, without many exceptions, his theory of the enjoyments of children. It is so far from being true, that few things amuse, and that nothing satisfies them, that the direct contrary must have been observed by every man attentive to the operations of the infant mind, which is amused with every thing new, and often completely satisfied with the merest trifle. The pleasures of philosophy are not indeed unfolded to the infant; but it by no means follows that he does not enjoy his rattle and his drum as much as the philosopher enjoys his telescope and air-pump; and if there be any truth in the science of physiognomy, the happiness of the former is much more pure and exquisite than that of the latter. That the most perfect music is vain noise to an infant, is far from being self-evident, unless the author confines the state of infancy to a very few months; and we are not disposed to believe, without better proof than we have yet received, that the relish of exquisite perfumes and highly-seasoned dishes adds much to the sum of human felicity.

§ *Encyclopédie Methodique, Logique, Metaphysique, et Morale*, tom. 4.

But however much we disapprove of many of these reflections, the following we cordially adopt as our own. "If we compare (says our author) the pleasures of sense with those which are purely intellectual, we shall find that the latter are infinitely superior to the former, as they may be enjoyed at all times and in every situation of life. What are the pleasures of the table, says Cicero, of gaming, and of women, compared with the delights of study? This taste increases with age, and no happiness is equal to it. Without knowledge and study, says Cato, life is almost the image of death (B). The pleasures of the soul are such, that it is frequent enough to see men preserve their gaiety during their whole life, notwithstanding a weak, diseased, and debilitated body. Scaron, who lived in the last century, was an example of this. Balzac, speaking of him, says, that Prometheus, Hercules, and Philoctetes, in profane, and Job in sacred, history, said many great things while they

(B) "Savages, barbarians, and peasants, enjoy little happiness except that of sensation. The happiness of a civilized and well-informed man consists of sensations, of ideas, and of a great number of affinities, altogether unknown to them. He not only enjoys the present, but the past and the future. He recals the agreeable idea of pleasures which he has tasted. It is great happiness, says an ancient, to have the recollection of good actions, of an upright intention, and of promises which we have kept."

they were afflicted with violent pain, but Scaron alone ſaid pleaſant things. I have ſeen, continues he, in many places of ancient hiſtory, conſtancy, and modeſty, and wiſdom, and eloquence, accompanying affliction, but he is the only inſtance wherein I have ſeen pleaſantry.

"There are men whoſe underſtandings are conſtantly on the ſtretch, and by this very means they are improved; but if the body were as conſtantly employed in the purſuit of ſenſual gratification, the conſtitution would ſoon be deſtroyed. The more we employ the mind we are capable of the greater exertion; but the more we employ the body we require the greater repoſe. There are beſides but ſome parts of the body capable of enjoying pleaſure; every part of it can experience pain. A toothach occaſions more ſuffering than the moſt conſiderable of our pleaſures can procure of enjoyment. Great pain may continue for any length of time; exceſſive pleaſures are almoſt momentary. Pleaſure carried to an extreme becomes painful; but pain, either by augmenting or diminiſhing it, never becomes agreeable. For the moment, the pleaſures of the ſenſes are perhaps more ſatisfactory; but in point of duration thoſe of the heart and mind are infinitely preferable. All the ſentiments of tenderneſs, of friendſhip, of gratitude, and of generoſity, are ſources of enjoyment for man in a ſtate of civilization. The damned are exceedingly unhappy, ſaid St Catherine de Sienna, if they are incapable of loving or being beloved.

"Pleaſure, continued for a great length of time, produces languor and fatigue, and excites ſleep; the continuation of pain is productive of none of theſe effects. Many ſuffer pain for eight days and even a month without interruption; an equal duration of exceſſive pleaſure would occaſion death.

"Time is a mere relative idea with regard to pleaſure and pain; it appears long when we ſuffer, and ſhort when we enjoy. If there exiſted no regular and uniform movement in nature, we would not be able from our ſenſations alone to meaſure time with any degree of exactneſs, for pain lengthens and pleaſure abridges it. From the languor of unoccupied time has ariſen the proverb expreſſive of our deſire to *kill* it. It is a melancholy reflection, and at the ſame time true, that there is no enjoyment which can effectually ſecure us from pain for the remainder of our lives; while there are examples of evils which hold men in conſtant ſorrow and pain during their whole exiſtence. Such then is the imperfection of the one and the power of the other.

"Pleaſure and pain are the ſources of morality; an action is juſt or unjuſt, good or otherwiſe, only as its natural tendency is to produce ſuffering or enjoyment to mankind. No crime could be committed againſt a being altogether inſenſible, nor could any good be beſtowed on it. Unleſs he were endowed with the deſire of pleaſure and the apprehenſion of pain, man, like an automaton, would act from neceſſity, without choice and without determination.

"All our paſſions are the developement of ſenſibility. If we were not poſſeſſed of feeling, we ſhould be deſtitute of paſſions; and as ſenſibility is augmented by civilization, the paſſions are multiplied; more active and vigorous in an extenſive and civilized empire than in a ſmall ſtate; more in the latter than among barbarous nations; and more in theſe laſt than among ſavages (See PASSION). There are more paſſions in France and England than in all the nations of Europe; becauſe every thing which ſerves to excite and foſter them is always in thoſe countries in the greateſt ſtate of fermentation. The mind is active; the ideas great, extenſive, and multiplied. And is it not the ſoul, the mind, and heart, which are the focus of all the paſſions?"

But wherever the paſſions are multiplied, the ſources of pleaſure and pain are multiplied with them. This being the caſe, it is impoſſible to preſcribe a fixed and general rule of happineſs ſuited to every individual. There are objects of pleaſure with regard to which all men of a certain education are agreed; but there are perhaps many more, owing to the variety of tempers and education, about which they differ. Every man forms ideas of enjoyment relative to his character; and what pleaſes one may be utterly deteſted by another. In proportion as a nation is civilized and extenſive, thoſe differences are remarkable. Savages, who are not acquainted with all the variety of European pleaſures, amuſe themſelves with very few objects. Owing to the want of civilization, they have ſcarcely any choice in the objects of taſte. They have few paſſions; we have many. But even in the nations of Europe pleaſure is infinitely varied in its modification and forms. Thoſe differences ariſe from manners, from governments, from political and religious cuſtoms, and chiefly from education. Meanwhile, however different and variable the ideas of pleaſure may be among nations and individuals, it ſtill remains a fact, that a certain number of perſons in all civilized ſtates, whether diſtinguiſhed by birth, or rank, or fortune, or talents, as they have nearly the ſame education ſo they form nearly the ſame ideas of happineſs: but to poſſeſs it, a man muſt give his chief application to the ſtate of his mind; and notwithſtanding all his efforts it is of uncertain duration. Happineſs is the ſunſhine of life: we enjoy it frequently at great intervals; and it is therefore neceſſary to know how to uſe it. All the productions of art periſh; the largeſt fortunes are diſſipated; rank, honour, and dignity paſs away like a fleeting ſhadow; the memory is impaired; all the faculties of the ſoul are extinguiſhed; the body ſinks under the infirmities of old age; and ſcarcely has one reached the boundaries of happineſs marked out by his imagination, when he muſt give place to another, and renounce all his pleaſures, all his hopes, all his illuſions; the fugitive images of which had given happineſs to the mind.

There are pleaſures, however, on which the mind may ſecurely reſt, which elevate man above himſelf, dignify his nature, fix his attention on ſpiritual things, and render him worthy of the care of Providence. Theſe are to be found in true religion; which procures for thoſe who practiſe its duties inexpreſſible happineſs in a better country, and is in this world the ſupport of the weak, and the ſweet conſolation of the unfortunate.

PLEBEIAN, any perſon of the rank of the common people. It is chiefly uſed in ſpeaking of the ancient Romans, who were divided into ſenators, patricians, and plebeians. The diſtinction was made by Romulus the founder of the city; who confined all dignities, civil, military, and ſacerdotal, to the rank of patricians. But to prevent the ſeditions which ſuch a diſtinction might produce through the pride of the higher order and the envy of the lower, he endeavoured to engage them

them to one another by reciprocal ties and obligations. Every plebeian was allowed to chooſe, out of the body of the patricians, a protector, who ſhould be obliged to aſſiſt him with his intereſt and ſubſtance, and to defend him from oppreſſion. Theſe protectors were called *patrons*; the protected, *clients*. It was the duty of the patron to draw up the contracts of the clients, to extricate them out of their difficulties and perplexities, and to guard their ignorance againſt the artfulneſs of the crafty. On the other hand, if the patron was poor, his clients were obliged to contribute to the portions of his daughters, the payment of his debts, and the ranſom of him and his children if they happened to be taken in war. The client and patron could neither accuſe nor bear witneſs againſt each other; and if either of them was convicted of having violated this law, the crime was equal to that of treaſon, and any one might with impunity ſlay the offender as a victim devoted to Pluto and the infernal gods. For more than 600 years we find no diſſenſions nor jealouſies between the patrons and their clients; not even in the times of the republic, when the people frequently mutinied againſt the great and powerful.

PLECTRANTHUS, in botany: A genus of the gymnoſpermia order, belonging to the didynamia claſs of plants; and in the natural method ranking under the 42d order, *Verticillatæ*. The calyx is monophyllous, ſhort, and bilabiated; the upper lip of which is large, oval, and bent upwards; the inferior lip is quadrifid, and divided into two laciniæ: the corolla is monopetalous, ringent, and turned back; the labiæ look different ways, and from the baſe of the tube there is a nectarium like a ſpur: the filaments are in a declining ſituation, with ſimple antheræ: the ſtylus filiform; the ſtigma bifid. It has four ſeeds covered only by the calyx. There are two ſpecies, viz. 1. The *fruticoſus*, a native of the Cape of Good Hope; 2. *Punctatus*, a native of Africa. The firſt flowers from June to September, the latter from January to May.

PLEDGE *(Plegius)*, in common law, a ſurety or gage, either real or perſonal, which the plaintiff or demandant is to find for his proſecuting the ſuit.

The word is ſometimes alſo uſed for *Frank Pledge*, which ſee.

To Pledge, in drinking, denotes to warrant, or be ſurety to one, that he ſhall receive no harm while he is taking his draught. The phraſe is referred by our antiquaries to the practice of the Danes, heretofore in England, who frequently uſed to ſtab or cut the throats of the natives while they were drinking.

Pledges of Goods for money. See Pawn.

PLEDGERY, or Pleggery, in law, ſuretiſhip, or an undertaking or anſwering for another.

PLEDGET, Bolster, or *Compreſs*, in ſurgery, a kind of flat tent laid over a wound, to imbibe the ſuperfluous humours, and to keep it clean.

PLEIADES, in fabulous hiſtory, the ſeven daughters of Atlas king of Mauritania and Pleione, were thus called from their mother. They were Maia, Electra, Taygete, Aſterope, Merope, Halcyone, and Celœno; and were alſo called *Atlantides*, from their father Atlas. Theſe princeſſes were carried off by Buſiris king of Egypt; but Hercules having conquered him, delivered them to their father: yet they afterwards ſuffered a new perſecution from Orion, who purſued them five years, till Jove, being prevailed on by their prayers, took them up into the heavens, where they form the conſtellation which bears their name.

Pleiades, in aſtronomy, an aſſemblage of ſeven ſtars, in the neck of the conſtellation Taurus.

They are thus called from the Greek πλειν, *navigare*, "to ſail;" as being terrible to mariners, by reaſon of the rains and ſtorms that frequently riſe with them. The Latins called them *vergiliæ*. from *ver*, "ſpring;" becauſe of their riſing about the time of the vernal equinox. The largeſt is of the third magnitude, and is called *lucida pleiadum*.

PLENARY, ſomething complete or full. Thus we ſay the pope grants *plenary* indulgences; *i. e.* full and entire remiſſions of the penalties due to all ſins. See Indulgences.

PLENIPOTENTIARY, a perſon veſted with full power to do any thing. See Ambassador.

PLENITUDE, the quality of a thing that is full, or that fills another. In medicine, it chiefly denotes a redundancy of blood and humours.

PLENUM, in phyſics, denotes, according to the Carteſians, that ſtate of things wherein every part of ſpace is ſuppoſed to be full of matter, in oppoſition to a Vacuum, which is a ſpace ſuppoſed devoid of all matter.

PLENUS flos, a full flower; a term expreſſive of the higheſt degree of luxuriance in flowers. See Botany, p. 428, 2d column. Such flowers, although the moſt delightful to the eye, are both vegetable monſters, and, according to the ſexualiſts, vegetable eunuchs; the unnatural increaſe of the petals conſtituting the firſt; the conſequent excluſion of the ſtamina or male organs, the latter. The following are well known examples of flowers with more petals than one; ranunculus, anemone, marſh-marygold, columbine, fennel-flower, poppy, pæony, pink, gilliflower, campion, viſcous campion, lily, crown imperial, tulip, narciſſus, rocket, mallow, Syrian mallow, apple, pear, peach, cherry, almond, myrtle, roſe, and ſtrawberry.

Flowers with one petal are not ſo ſubject to fullneſs. The following, however, are inſtances: polianthus, hyacinth, primroſe, crocus, meadow-ſaffron, and thorn-apple, tho' Kramer has aſſerted that a full flower with one petal is a contradiction in terms. In flowers with one petal, the mode of luxuriance, or impletion, is by a multiplication of the diviſions of the limb or upper part; in flowers with more petals than one, by a multiplication of the petals or nectarium.

To take a few examples. Columbine is rendered full in three different ways: 1. By the multiplication of its petals, and total excluſion of the nectaria; 2. By the multiplication of the nectaria, and excluſion of the petals; or, 3. By ſuch an increaſe of the nectaria only as does not exclude the petals, between each of which are interjected three nectaria, placed one within another. Again, fennel-flower is rendered full by an increaſe of the nectaria only; narciſſus, either by a multiplication of its cup and petals, or of its cup only; lark-ſpur commonly by an increaſe of the petals and excluſion of the ſpur, which is its nectarium. In *ſaponaria concava anglia*, the impletion is attended with the ſingular effect of incorporating the petals, and reducing their number from five to one; and in gelder-roſe, the luxuriance is effected by an increaſe both in magnitude and number of

of the circumference or margin of the head of flowers, in the plain, wheel-ſhaped, barren florets; and an excluſion of all the bell-ſhaped hermaphrodite florets of the centre or diſk.

Hitherto we have treated of plenitude in ſimple flowers only: the inſtance juſt now adduced ſeems to connect the different modes of impletion in them and compound flowers. Before proceeding farther, however, it will not be improper to premiſe, that as a ſimple luxuriant flower is frequently, by beginners, miſtaken for a compound flower in a natural ſtate, ſuch flowers may always be diſtinguiſhed with certainty by this rule: That in ſimple flowers, however luxuriant, there is but one piſtillum or female organ; whereas in compound flowers, each floret, or partial flower, is furniſhed with its own proper piſtillum. Thus in hawk-weed, a compound flower, each flat or tongue-ſhaped floret in the aggregate has its five ſtamina and naked ſeed, which laſt is in effect its piſtillum; whereas, in a luxuriant lychnis, which is a ſimple flower, there is found only one piſtillum or female organ common to the whole.

In a compound radiated flower, which generally conſiſts of plain florets in the margin or radius, and tubular or hollow florets in the centre or diſc; plenitude is effected either by an increaſe of the florets in the margin, and a total excluſion of thoſe in the diſc; which mode of luxuriance is termed *impletion by the radius*, and reſembles what happens in the gelder-roſe: or by an elongation of the hollow florets in the centre, and a leſs profound diviſion of their brims; which is termed *impletion by the diſc.* In the firſt mode of luxuriance, the florets in the centre, which are always hermaphrodite or male, are entirely excluded; and in their place ſucceed florets ſimilar in ſex to thoſe of the radius. Now, as the florets in the margin of a radiated compound flower are found to be always either female, that is, furniſhed with the piſtillum only; or neuter, that is, furniſhed with neither ſtamina nor piſtillum; it is evident, that a radiated compound flower, filled by the radius, will either be entirely female, as in feverfew, daiſy, and African marigold; or entirely neuter, as in ſunflower, marygold, and centaury: hence it will always be eaſy to diſtinguiſh ſuch a luxuriant flower from a compound flower with plain florets in a natural ſtate; as theſe flowers are all hermaphrodite, that is, furniſhed with both ſtamina and piſtillum. Thus the full flowers of African marigold have each floret furniſhed with the piſtillum or female organ only: the natural flowers of dandelion, which, like the former, is compoſed of plain florets, are furniſhed with both ſtamina and piſtillum.

In the ſecond mode of luxuriance, termed *impletion by the diſc*, the florets in the margin ſometimes remain unchanged: but moſt commonly adopt the figure of thoſe in the centre, without, however, ſuffering any alteration in point of ſex; ſo that confuſion is leſs to be apprehended from this mode of luxuriance than from the former; beſides, the length to which the florets in the centre run out is of itſelf a ſufficient diſtinction, and adapted to excite at once an idea of luxuriance. Daiſy, feverfew, and African marigold, exhibit inſtances of this as well as of the former mode of impletion.

In luxuriant compound flowers with plain florets, the *ſemifloſculoſi* of Tournefort, the ſtigma or ſummit of the ſtyle in each floret is lengthened, and the ſeed-buds are enlarged and diverge; by which characters ſuch flowers may always be diſtinguiſhed from flowers of the ſame kind in a natural ſtate. Scorzonera, nipple-wort, and goat's-beard, furniſh frequent inſtances of the plenitude alluded to.

Laſtly, the impletion of compound flowers with tubular or hollow florets, the *floſculoſi* of Tournefort, ſeems to obſerve the ſame rules as that of radiated flowers juſt delivered. In everlaſting-flower, the *xeranthemum* of Linnæus, the impletion is ſingular, being effected by the enlargement and expanſion of the inward chaffy ſcales of the calyx. Theſe ſcales, which become coloured, are greatly augmented in length, ſo as to overtop the florets, which are ſcarce larger than thoſe of the ſame flower in a natural ſtate. The florets too in the margin, which in the natural flower are female, become, by luxuriance, barren; that is, are deprived of the piſtillum; the ſtyle, which was very ſhort, ſpreads, and is of the length of the chaffy ſcales; and its ſummits, formerly two in number, are metamorphoſed into one.

Full flowers are more eaſily referred to their reſpective genera in methods founded upon the calyx, as the flower-cup generally remains unaffected by this higheſt degree of luxuriance.

PLEONASM, a figure in rhetoric, whereby we uſe words ſeemingly ſuperfluous, in order to expreſs a thought with the greater energy; ſuch as, "I ſaw it with my own eyes," &c. See Oratory, n° 67.

PLESCOW, a town of Ruſſia, capital of a duchy of the ſame name, with an archbiſhop's ſee, and a ſtrong caſtle. It is a large place, and divided into four parts, each of which is ſurrounded with walls. It is ſeated on the river Muldow, where it falls into the lake Pleſcow, 80 miles ſouth of Narva, and 150 ſouth by weſt of Peterſburg. E. Long. 27. 52. N. Lat. 57. 58.

Plescow, a duchy in Ruſſia, between the duchies of Novogorod, Lithuania, Livonia, and Ingria.

PLESSIS-les-tours, a royal palace of France, within half a league of Tours. It was built by Louis XI. and in it he died in the year 1483. It is ſituated in a plain ſurrounded by woods, at a ſmall diſtance from the Loire. The building is yet handſome, though built of brick, and converted to purpoſes of commerce.

PLETHORA, in medicine, from πληθος, "plenitude." A plethora is when the veſſels are too much loaded with fluids. The plethora may be ſanguine or ſerous. In the firſt there is too much craſſamentum in the blood, in the latter too little. In the ſanguine plethora, there is danger of a fever, inflammation, apoplexy, rupture of the blood-veſſels, obſtructed ſecretions, &c.: in the ſerous, of a dropſy, &c. A rarefaction of the blood produces all the effects of a plethora; it may accompany a plethora, and ſhould be diſtinguiſhed therefrom. Mr Bromfield obſerves, that a ſanguine plethora may thus be known to be preſent by the pulſe. An artery overcharged with blood is as incapable of producing a ſtrong full pulſe, as one that contains a deficient quantity; in both caſes there will be a low and weak pulſe. To diſtinguiſh rightly, the pulſe muſt not be felt with one or two fingers on the carpal artery; but if three or four fingers cover a conſiderable length of the artery, and we preſs hard for ſome time on it, and then ſuddenly raiſe all theſe fingers except that which is neareſt to the patient's hand, the influx of the blood, if there is a plethora, will be ſo rapid as to raiſe the other finger, and make us ſenſible of the fulneſs. The

sanguine plethora is relieved by bleeding: the serous by purging, diuretics, and sweating. See MEDICINE, n° 100.

PLEURA, in anatomy, a thin membrane covering the inside of the thorax. See ANATOMY, n° 113.

PLEURITIS, or PLEURISY. See MEDICINE, n° 185.

PLEURONECTES, in ichthyology, a genus belonging to the order of thoracici. Both eyes are on the same side of the head; there are from four to five rays in the gill-membrane; the body is compressed; the one side resembling the back, the other the belly. There are 17 species; the most remarkable are,

1. The hyppoglossus, or holibut. This is the largest of the genus: some have been taken in our seas weighing from 100 to 300 pounds; but much larger are found in those of Newfoundland, Greenland, and Iceland, where they are taken with a hook and line in very deep water. They are part of the food of the Greenlanders, who cut them into large slips, and dry them in the sun. They are common in the London markets, where they are exposed to sale cut into large pieces. They are very coarse eating, excepting the part which adheres to the side fins, which is extremely fat and delicious, but surfeiting. They are the most voracious of all flat fish. There have been instances of their swallowing the lead weight at the end of a line, with which the seamen were sounding the bottom from on board a ship. The holibut, in respect to its length, is the narrowest of any of this genus except the sole. It is perfectly smooth, and free from spines either above or below. The colour of the upper part is dusky; beneath, of a pure white. We do not count the rays of the fins in this genus; not only because they are so numerous, but because nature hath given to each species characters, independent of these rays, sufficient to distinguish them by. These flat fish swim sidewise; for which reason Linnæus hath styled them *pleuronectes*.

2. The platessa, or plaise, are very common on most of our coasts, and sometimes taken of the weight of 15 pounds; but they seldom reach that size, one of eight or nine pounds being reckoned a large fish. The best and largest are taken off Rye on the coast of Sussex, and also off the Dutch coasts. They spawn in the beginning of February. They are very flat, and much more square than the preceding. Behind the left eye is a row of six tubercles, that reaches to the commencement of the lateral line. The upper part of the body and fins are of a clear brown, marked with large bright orange-coloured spots: the belly is white.

3 The flesus, or flounder, inhabits every part of the British sea, and even frequents our rivers at a great distance from the salt waters; and for this reason some writers call it the *passer fluviatilis*. It never grows large in our rivers, but is reckoned sweeter than those that live in the sea. It is inferior in size to the plaise, seldom or never weighing more than six pounds. It may very easily be distinguished from the plaise, or any other fish of this genus, by a row of sharp small spines that surround its upper sides, and are placed just at the junction of the fins with the body. Another row marks the side-line, and runs half way down the back. The colour of the upper part of the body is a pale brown, sometimes marked with a few obscure spots of dirty yellow; the belly is white.

4. The limanda, or dab, is found with the other species, but is less common. It is in best season during February, March, and April: they spawn in May and June, and become flabby and watery the rest of summer. They are superior in quality to the plaise and flounder, but far inferior in size. It is generally of an uniform brown colour on the upper side, though sometimes clouded with a darker. The scales are small and rough, which is a character of this species. The lateral line is extremely incurvated at the beginning, then goes quite straight to the tail. The lower part of the body is white.

5. The solea, or sole, is found on all our coasts; but those on the western shores are much superior in size to those on the north. On the former they are sometimes taken of the weight of six or seven pounds, but towards Scarborough they rarely exceed one pound; if they reach two, it is extremely uncommon. They are usually taken in the trawl-net: they keep much at the bottom, and feed on small shell-fish. It is of a form much more narrow and oblong than any other of the genus. The irides are yellow; the pupils of a bright sapphirine colour: the scales are small, and very rough: the upper part of the body is of a deep brown; the tip of one of the pectoral fins black; the under part of the body white; the lateral line is straight; the tail rounded at the end. It is a fish of a very delicate flavour; but the small soles are in this respect much superior to large ones. By the ancient laws of the Cinque Ports, no one was to take soles from the 1st of November to the 15th of March; neither was any body to fish from sun-setting to sun-rising, that the fish might enjoy their night-food. The chief fishery for them is at Brixham in Torbay.

6. The maximus, or turbot, grows to a very large size: Mr Pennant has seen them of 23 pounds weight, but has heard of some that weighed 30. The turbot is of a remarkable square form: the colour of the upper part of the body is cinereous, marked with numbers of black spots of different sizes: the belly is white; the skin is without scales, but greatly wrinkled, and mixed with small short spines, dispersed without any order.—These fish are taken chiefly off the north coast of England, and others off the Dutch coast. See *Turbot* FISHERY.

PLEURS, a town in France, which was buried under a mountain in the year 1618. See our article MOUNTAIN, p. 430. Of this fatal circumstance, Bishop Burnet, in his Travels, p. 96. gives the following account. "Having mentioned (says the Bishop) some falls of mountains in these parts (viz. near the Alps), I cannot pass by the extraordinary fate of the town of Pleurs, about a league from Chavennes to the north.—The town was half the bigness of Chavennes, but much more nobly built; for, besides the great palace of the Francken, that cost some millions, there were many other palaces built by rich factors both of Milan and the other parts of Italy, who, liking the situation and air, as well as the freedom of the government, gave themselves all the indulgences that a vast wealth could furnish. By one of the palaces that was a little distant from the town, and was not overwhelmed with it, one may judge of the rest. It was an out-house of the family of the Francken, and yet it may compare with many palaces in Italy. The voluptuousness of this place be-

1 came

came very crying; and Madam de Salis told me that ſhe heard her mother often relate ſome paſſages of a Proteſtant miniſter's ſermons that preached in a little church there, who warned them often of the terrible judgments of God which were hanging over their heads, and which he believed would ſuddenly break out upon them.

"On the 25th of Auguſt 1628, an inhabitant came and told them to be gone, for he ſaw the mountains cleaving; but he was laughed at for his pains. He had a daughter whom he perſuaded to leave all and go with him; but when ſhe was ſafe out of town, ſhe called to mind that ſhe had not locked the door of a room in which ſhe had ſome things of value, and ſo ſhe went back to do that, and was buried with the reſt; for at the hour of ſupper the hill fell down, and buried the town and all the inhabitants, to the number of 2200, ſo that not one perſon eſcaped. The fall of the mountains did ſo fill the channel of the river, that the firſt news thoſe of Chavennes had of it was by the failing of their river; for three or four hours there came not a drop of water, but the river wrought for itſelf a new courſe, and returned to them.

"I could hear no particular character of the man who eſcaped (continues the Biſhop); ſo I muſt leave the ſecret reaſon of ſo ſingular a preſervation to the great diſcovery, at the laſt day, of thoſe ſteps of Divine Providence that are now ſo unaccountable. Some of the family of the Francken got ſome miners to work under ground, to find out the wealth that was buried in their houſe; for, beſides their plate and furniture, there was a great deal of caſh and many jewels in the houſe. The miners pretended they could find nothing; but they went to their country of Tirol and built fine houſes, and a great wealth appeared, of which no other viſible account could be given but this, that they had found ſome of that treaſure."

PLEXUS, among anatomiſts, a bundle of ſmall veſſels interwoven in the form of net-work: thus a congeries of veſſels within the brain is called *plexus choroides*, *reticularis*, or *retiformis*. See ANATOMY, n° 136.

A plexus of nerves is an union of two or more nerves, forming a ſort of ganglion or knot.

PLICA POLONICA, or *plaited hair*, is a diſeaſe peculiar to Poland; whence the name. See MEDICINE, n° 355. Mr Coxe, who gives a ſhort account of it, attempts likewiſe to give the phyſical cauſes of it. Many cauſes of this kind, he tells us, have been ſuppoſed to concur in rendering the plica more frequent in thoſe regions than in other parts. It would be an endleſs work to enumerate the various conjectures with which each perſon has ſupported his favourite hypotheſis.— The moſt probable are thoſe aſſigned by Dr Vicat: The firſt cauſe is the nature of the Poliſh air, which is rendered inſalubrious by numerous woods and moraſſes, and occaſionally derives an uncommon keenneſs even in the midſt of ſummer from the poſition of the Carpathian mountains; for the ſouthern and ſouth-eaſterly winds, which uſually convey warmth in other regions, are in this chilled in their paſſage over their ſnowy ſummits. The ſecond is, unwholeſome water; for although Poland is not deficient in good ſprings, yet the common people uſually drink that which is neareſt at hand, taken indiſcriminately from rivers, lakes, and even ſtagnant pools. The third cauſe is the groſs inattention of the natives to cleanlineſs; for experience ſhows, that thoſe who are not negligent in their perſons and habitations, are leſs liable to be afflicted with the plica than others who are deficient in that particular. Thus perſons of higher rank are leſs ſubject to this diſorder than thoſe of inferior ſtations; the inhabitants of large towns than thoſe of ſmall villages; the free peaſants than thoſe in an abſolute ſtate of vaſſalage; the natives of Poland Proper than thoſe of Lithuania. Whatever we may determine as to the poſſibility that all or any of theſe cauſes, by themſelves, or in conjunction with others, originally produced the diſorder; we may venture to aſſert, that they all, and particularly the laſt, aſſiſt its propagation, inflame its ſymptoms, and protract its cure.

In a word, the plica polonica appears to be a contagious diſtemper; which, like the leproſy, ſtill prevails among a people ignorant in medicine, and inattentive to check its progreſs, but is rarely known in thoſe countries where proper precautions are taken to prevent its ſpreading.

PLIMPTON, a town of Devonſhire, in England, with a market on Saturdays. It is ſeated on a branch of the river Plime, and had once a caſtle, now in ruins. It ſends two members to parliament; is ſeven miles E. of Plymouth, and 218 W. by S. of London. W. Long. 4. 0. N. Lat. 50. 22.

PLINIA, in botany; a genus of plants of the polyandria monogynia claſs, deſcribed by Plumier and Linnæus. The empalement is divided into five ſegments; the flower conſiſts of five petals; the ſtamina are numerous filaments, ſlender, and as long as the flower; the antheræ are ſmall, and ſo is the germen of the piſtil; the ſtyle is ſubulated, and of the length of the ſtamina; the ſtigma is ſimple; the fruit is a large globoſe berry, of a ſtriated or ſulcated ſurface, containing only one cell, in which is a very large, ſmooth, and globoſe ſeed. There is only one ſpecies.

PLINTH, ORLE, or *Orlo*, in architecture, a flat ſquare member, in the form of a brick. It is uſed as the foundation of columns, being that flat ſquare table under the moulding of the baſe and pedeſtal at the bottom of the whole order. It ſeems to have been originally intended to keep the bottom of the original wooden pillars from rotting. Vitruvius alſo calls the Tuſcan abacus *plinth*.

PLINTH of a Statue, &c. is a baſe, either flat, round, or ſquare, that ſerves to ſupport it.

PLINTH of a Wall, denotes two or three rows of bricks advancing out from a wall; or, in general, any flat high moulding, that ſerves in a front-wall to mark the floors, to ſuſtain the eaves of a wall, or the larmier of a chimney.

PLINY the ELDER, or *Cæcilius Plinius Secundus*, one of the moſt learned men of ancient Rome, was deſcended from an illuſtrious family, and born at Verona. He bore arms in a diſtinguiſhed poſt; was one of the college of Augurs; became intendant of Spain; and was employed in ſeveral important affairs by Veſpaſian and Titus, who honoured him with their eſteem. The eruption of Mount Veſuvius, which happened in the year 79, proved fatal to him. His nephew, Pliny the Younger, relates the circumſtances of that dreadful eruption, and the death of his uncles, in a letter to Tacitus.

Pliny.

citus. Pliny the Elder wrote a Natural Hiſtory in 37 books, which is ſtill extant, and has had many editions; the moſt eſteemed of which is that of Father Hardouin, printed at Paris in 1723, in two volumes folio.

Pliny the Younger, nephew of the former, was born in the ninth year of Nero, and the 62d of Chriſt, at Novocomum, a town upon the lake Larius, near which he had ſeveral beautiful villas. Cæcilius was the name of his father, and Plinius Secundus that of his mother's brother, who adopted him. He brought into the world with him fine parts and an elegant taſte, which he did not fail to cultivate early; for, as he tells us himſelf, he wrote a Greek tragedy at 14 years of age. He loſt his father when he was young; and had the famous Virginius for his tutor or guardian, whom he has ſet in a glorious light. He frequented the ſchools of the rhetoricians, and heard Quintilian; for whom he ever after entertained ſo high an eſteem, that he beſtowed a conſiderable portion upon his daughter at her marriage. He was in his 18th year when his uncle died; and it was then that he began to plead in the forum, which was the uſual road to dignities. About a year after, he aſſumed the military character, and went into Syria with the commiſſion of tribune: but this did not ſuit his taſte any more than it had done Tully's; and therefore we find him returning after a campaign or two. He tells us, that in his paſſage homewards he was detained by contrary winds at the iſland Icaria, and how he employed himſelf in making verſes: he enlarges in the ſame place upon his poetical exercitations; yet poetry was not the ſhining part of his character any more than it had been of Tully's.

Upon his return from Syria, he married a wife, and ſettled at Rome: it was in the reign of Domitian. During this moſt perilous time, he continued to plead in the forum, where he was diſtinguiſhed not more by his uncommon abilities and eloquence, than by his great reſolution and courage, which enabled him to ſpeak boldly, when ſcarcely one elſe durſt ſpeak at all. On theſe accounts he was often ſingled out by the ſenate to defend the plundered provinces againſt their oppreſſive governors, and to manage other cauſes of a like important and dangerous nature. One of theſe was for the province of Bœtica, in their proſecution of Bæbius Maſſa; in which he acquired ſo general an applauſe, that the emperor Nerva, then a private man, and in baniſhment at Tarentum, wrote to him a letter, in which he congratulated not only Pliny, but the age which had produced an example ſo much in the ſpirit of the ancients. Pliny relates this affair in a letter to Cornelius Tacitus; and he was ſo pleaſed with it himſelf, that he could not help intreating this friend to record it in his hiſtory. He intreats him, however, with infinitely more modeſty than Tully had intreated Lucceius upon the ſame occaſion: and though he might imitate Cicero in the requeſt, as he profeſſes to have conſtantly ſet that great man before him for a model, yet he took care not to tranſgreſs the bounds of decency in his manner of making it. He obtained the offices of queſtor and tribune, and luckily went unhurt through the reign of Domitian: there is, however, reaſon to ſuppoſe, if that emperor had not died juſt as he did, that Pliny would have ſhared the fate of many other great men; for he tells us himſelf, that his name was afterwards found in Domitian's tablets, among the number of thoſe who were deſtined to deſtruction.

Pliny.

He loſt his wife in the beginning of Nerva's reign, and ſoon after married his beloved Calphurnia, of whom we read ſo much in his Epiſtles. He had not, however, any children by any of his wives: and hence we find him thanking Trajan for the *jus trium liberorum*, which he afterwards obtained of that emperor for his friend Suetonius Tranquillus. He hints alſo, in his letter of thanks to Trajan, that he had been twice married in the reign of Domitian. He was promoted to the conſulate by Trajan in the year 100, when he was 38 years of age; and in this office pronounced that famous panegyric, which has ever ſince been admired, as well for the copiouſneſs of the topics as the elegance of addreſs. Then he was elected augur, and afterwards made proconſul of Bithynia; whence he wrote to Trajan that curious letter concerning the primitive Chriſtians; which, with Trajan's reſcript, is happily extant among his Epiſtles. Pliny's letter, as Mr Melmoth obſerves in a note upon the paſſage, is eſteemed as almoſt the only genuine monument of eccleſiaſtical antiquity relating to the times immediately ſucceeding the apoſtles, it being written at moſt not above 40 years after the death of St Paul. It was preſerved by the Chriſtians themſelves, as a clear and unſuſpicious evidence of the purity of their doctrines, and is frequently appealed to by the early writers of the church againſt the calumnies of their adverſaries. It is not known what became of Pliny after his return from Bithynia; whether he lived at Rome, or what time he ſpent at his country-houſes. Antiquity is alſo ſilent as to the time of his death: but it is conjectured that he died either a little before or ſoon after that excellent prince, his admired Trajan; that is, about the year of Chriſt 116.

Pliny was one of the greateſt wits, and one of the worthieſt men, among the ancients. He had fine parts, which he cultivated to the utmoſt; and he accompliſhed himſelf with all the various kinds of knowledge which could ſerve to make him either uſeful or agreeable. He wrote and publiſhed a great number of things; but nothing has eſcaped the wreck of time except the books of Letters, and the panegyric upon Trajan. This has ever been conſidered as a maſterpiece: and if he has, as ſome think, almoſt exhauſted all the ideas of perfection in a prince, and gone perhaps a little beyond the truth, yet it is allowed that no panegyriſt was ever poſſeſſed of a finer ſubject, and on which he might better indulge in all the flow of eloquence, without incurring the ſuſpicion of flattery and lies. His letters ſeem to have been intended for the public; and in them he may be conſidered as writing his own memoirs. Every epiſtle is a kind of hiſtorical ſketch, wherein we have a view of him in ſome ſtriking attitude, either of active or contemplative life. In them are preſerved anecdotes of many eminent perſons, whoſe works are come down to us, as Suetonius, Silius Italicus, Martial, Tacitus, and Quintilian; and of curious things, which throw great light upon the hiſtory of thoſe times. They are written with great politeneſs and ſpirit; and if they abound too much in turn and metaphor, we muſt impute it to that degeneracy of taſte which was then accompanying the degenerate manners of Rome. Pliny, however, ſeems to have

preserved himself in this latter respect from the general contagion: whatever the manners of the Romans were, his were pure and incorrupt. His writings breathe a spirit of transcendent goodness and humanity: his only imperfection is, he was too desirous that the public and posterity should know how humane and good he was. We have two elegant English translations of his Epistles; the one by Mr Melmoth, and the other by Lord Orrery.

PLOCAMA, in botany; a genus of the monogynia order, belonging to the pentandria class of plants. The calyx is quinquedentate; the fruit a berry and trilocular, with solitary seeds. Of this there is only one species, viz. the *pendula*, a native of the Canaries.

PLOCE. See Oratory, p. 433.

PLOCKSKO, a town of Poland, and capital of a palatinate of the same name, with a castle and a bishop's see. The churches are very magnificent; and it is built upon a hill, whence there is a fine prospect every way, near the river Vistula. It is 25 miles south-east of Uladislaw, and 65 west of Warsaw. E. Long. 19. 29. N. Lat. 52. 46.

Plocksko, a palatinate of Poland, bounded on the north by Regal Prussia, on the east by the palatinate of Mazovia, on the south by the Vistula, and on the west by the palatinate of Inovladislaw. The capital town is of the same name.

PLOEN is a town of Germany, in the circle of Lower Saxony, and capital of Holstein. It stands on the banks of a lake of the same name, and gave title to a duke, till by the death of the last duke Charles without male issue it escheated to the king of Denmark in 1761. The ducal palace, rising in the midst of the town, on an elevated spot of ground, and overlooking the lake, is a very picturesque object. The town stands 22 miles north-west of Lubeck, and 10 south-east of Kiell. E. Long. 10. 30. N. Lat. 54. 11.

PLOMO, in metallurgy, is a name given by the Spaniards, who have the care of the silver-mines, to the silver ore, when found adhering to the surface of stones, and when it incrusts their cracks and cavities like small and loose grains of gun-powder. Though these grains be few in number, and the rest of the stone have no silver in it, yet they are always very happy when they find it, as it is a certain token that there is a rich vein somewhere in the neighbourhood. And if in digging forwards they still meet with these grains, or the plomo in greater quantity, it is a certain sign that they are getting more and more near the good vein.

PLOT (Dr Robert), a learned antiquarian and philosopher, was born at Sutton-barn, in the parish of Borden in Kent, in the year 1641, and studied in Magdalen-hall, and afterwards in University-college, Oxford. In 1682 he was elected secretary of the Royal Society, and published the Philosophical Transactions from nº 143 to nº 166 inclusive. The next year Elias Ashmole, Esq; appointed him first keeper of his museum, and about the same time the vice-chancellor nominated him first professor of chemistry in the university of Oxford. In 1687 he was made secretary to the Earl Marshal, and the following year received the title of *Historiographer* to King James II. In 1690 he resigned his professorship of chemistry, and likewise his place of keeper of the museum, to which he presented a very large collection of natural curiosities; which were those he had described in his histories of Oxfordshire and Staffordshire: the former published at Oxford in 1677, folio, and reprinted with additions and corrections in 1705; and the latter was printed in the same size in 1686. In January 1694-5, Henry Howard, Earl Marshal, nominated him Mobray-herald extraordinary; two days after which he was constituted register of the court of honour; and, on the 30th of April 1696, he died of the stone at his house in Borden.

As Dr Plot delighted in natural history, the above works were designed as essays towards a Natural History of England; and he had actually formed a design of travelling through England and Wales for that purpose. He accordingly drew up a plan of his scheme in a letter to the learned Bishop Fell; which is inserted at the end of the second volume of Leland's Itinerary, of the edition of 1744. Amongst several MSS. which he left behind him were large materials for the "Natural History of Kent, Middlesex, and the city of London." Besides the above works, he published *De origine fontium tentamen philosophicum*, 8vo, and nine papers in the Philosophical Transactions.

Plot, in dramatic poetry, is sometimes used for the fable of a tragedy or comedy; but more properly for the knot or intrigue, which makes the *embarras* of any piece. See Poetry.

Plot, in surveying, the plan or draught of any field, farm, or manor, surveyed with an instrument, and laid down in the proper figure and dimensions.

PLOTINUS, a Platonic philosopher in the third century. He was born at Lycopolis, a city of Egypt, in 204; and began very early to show a great singularity both in his taste and manners: for, at eight years of age, when he went to school, he used to run to his nurse, and uncover her breast to suck; and would have continued that practice longer, if he had not been discouraged by her. At 28 years of age he had a strong desire to study philosophy, on which occasion he was recommended to the most famous professors of Alexandria. He was not satisfied with their lectures; but, upon hearing those of Ammonius, he confessed that this was the man he wanted. He studied for 11 years under that excellent master, and then went to hear the Persian and Indian philosophers: for in 243, when the emperor Gordianus intended to wage war against the Persians, he followed the Roman army, but probably repented of it; for it was with difficulty he could save his life by flight, after the emperor had been slain. He was then 39; and the year following he went to Rome, and read philosophical lectures in that city; but avoided following the example of Erennius and Origen, his fellow-pupils, who, having promised with him not to reveal some hidden and excellent doctrines they had received from Ammonius, had nevertheless forfeited their word. Plotinus continued ten years in Rome, without writing any thing; but, in his 50th year, Porphyry became his scholar; who, being of an exquisitely fine genius, was not satisfied with superficial answers, but required to have all difficulties thoroughly explained; and therefore Plotinus, to treat things with greater accuracy, was obliged to write more books. He had before written 21 books, and during the six years of Porphyry's stay with him he wrote 24, and 9 after Porphyry's leaving Rome, in all 54. The Romans had a high veneration for him; and he passed for a man of such judgment

Plotinus.

ment and virtue, that many perſons of both ſexes, when they found themſelves dying, intruſted him, as a kind of guardian angel, with the care of their eſtates and children. He was the arbiter of numberleſs law-ſuits; and conſtantly behaved with ſuch humanity and rectitude of mind, that he did not create himſelf one enemy during the 26 years he reſided in Rome. He, however, did not meet with the ſame juſtice from all of his own profeſſion; for Olympias a philoſopher of Alexandria, being envious of his glory, uſed his utmoſt endeavours, though in vain, to ruin him. The emperor Gallienus, and the empreſs Salonina, had a very high regard for him; and, had it not been for the oppoſition of ſome jealous courtiers, they would have had the city of Campania rebuilt, and given to him with the territory belonging to it, to eſtabliſh a colony of philoſophers, and to have it governed by the ideal laws of Plato's commonwealth. He laboured under various diſorders during the laſt year of his life, which obliged him to leave Rome, when he was carried to Campania to the heirs of one of his friends, who furniſhed him with every thing neceſſary; and he died there in the year 270, at the age of 66, and in the nobleſt manner that an heathen philoſopher could do, theſe being his words as he breathed his laſt: "I am labouring with all my might to return the divine part of me to that Divine Whole which fills the univerſe."

We have already remarked that the ideas of Plotinus were ſingular and extraordinary; and we ſhall now ſhow that they were ſo. He was aſhamed of being lodged in a body, for which reaſon he did not care to tell the place of his birth or family. The contempt he had for all earthly things, was the reaſon why he would not permit his picture to be drawn: and when his diſciple Amelius was urgent with him upon this head, "Is it not enough (ſaid he) to drag after us, whitherſoever we go, that image in which nature has ſhut us up? Do you think that we ſhould likewiſe tranſmit to future ages an image of that image, as a ſight worthy of their attention?" From the ſame principle, he refuſed to attend to his health; for he never made uſe of preſervatives or baths, and did not even eat the fleſh of tame animals. He eat but little, and abſtained very often from bread; which, joined to his intenſe meditation, kept him very much from ſleeping. In ſhort, he thought the body altogether below his notice; and had ſo little reſpect for it, that he conſidered it as a priſon, from which it would be his ſupreme happineſs to be freed. When Amelius, after his death, inquired about the ſtate of his ſoul of the oracle of Apollo, he was told, "that it was gone to the aſſembly of the bleſſed, where charity, joy, and a love of the union with God prevail:" and the reaſon given for it, as related by Porphyry, is, "that Plotinus had been peaceable, gracious, and vigilant; that he had perpetually elevated his ſpotleſs ſoul to God; that he had loved God with his whole heart; that he had diſengaged himſelf, to the utmoſt of his abilities, from this wretched life; that, elevating himſelf with all the powers of his ſoul, and by the ſeveral gradations taught by Plato, towards that Supreme Being which fills the univerſe, he had been enlightened by him; had enjoyed the viſion of him without the help or interpoſition of ideas; had, in ſhort, been often united to him." This is the account of Porphyry, who tells us alſo, that he himſelf had once been favoured with the viſion. To this account, however, we need ſcarcely add, that little credit is due: it agrees pretty much with modern enthuſiaſm and the reveries of Behmeniſts. Plotinus had alſo his familiar ſpirit, as well as Socrates; but, according to Porphyry, it was not one of thoſe called *demons*, but of the order of thoſe who are called *gods*; ſo that he was under the protection of a genius ſuperior to that of other men. The ſuperiority of his genius puffed him up not a little: for when Amelius deſired him to ſhare in the ſacrifices, which he uſed to offer up on ſolemn feſtivals, "It is their buſineſs (replied Plotinus) to come to me, not mine to go to them:" "which lofty anſwer (ſays Porphyry) no one could gueſs the reaſon of, or dared to aſk."

Porphyry put the 54 books of Plotinus in order, and divided them into ſix enneaſes. The greater part of them turn on the moſt high-flown ideas in metaphyſics; and this philoſopher ſeems, in certain points, not to differ much from Spinoza. He wrote two books to prove, that "all being is one and the ſame;" which is the very doctrine of Spinoza. He inquires, in another book, "Whether there are many ſouls, or only one?" His manner of compoſing partook of the ſingularity of his nature: he never read over his compoſitions after he had written them; he wrote a bad hand, and was not exact in his orthography: he ſtood in need, therefore, of a faithful friend to reviſe and correct his writings; and he choſe Porphyry for this purpoſe before Amelius, who had, however, been his diſciple 24 years, and was very much eſteemed by him. Some have accuſed Plotinus of plagiariſm, with regard to Numenius; a ſlander which Amelius refuted. Longinus was once much prejudiced againſt our great philoſopher, and wrote againſt his Treatiſe of Ideas, and againſt Porphyry's anſwer in defence of that treatiſe. He afterwards conceived a high eſteem for him; ſought induſtriouſly for all his books; and, in order to have them very correct, deſired Porphyry to lend him his copy; but at the ſame time wrote to him in the following manner: "I always obſerved to you, when we were together, when we were at a diſtance from one another, as well as when you lived at Tyre, that I did not comprehend many of the ſubjects treated of by Plotinus; but that I was extremely fond of his manner of writing, the variety of his knowledge, and the order and diſpoſition of his queſtions, which are altogether philoſophical." "This ſingle paſſage (ſays Bayle) ſhows the exalted genius, the exquiſite diſcernment, and judicious penetration of Longinus. It cannot be denied, that moſt ſubjects which this philoſopher examines are incomprehenſible; nevertheleſs, we diſcover in his works a very elevated, fruitful, and capacious genius, and a cloſe way of reaſoning. Had Longinus been an injudicious critic, had he not poſſeſſed an exalted and beautiful genius, he would not have been ſo ſenſible of Plotinus's obſcurity: for no perſons complain leſs of the obſcurity of a book, than thoſe whoſe thoughts are confuſed and underſtanding is ſhallow." Marſilius Ficinus, at the requeſt of Coſmo de Medicis, made a Latin verſion of the works of Plotinus, with a ſummary and analyſis of each book; which was printed at Baſil, firſt by itſelf, in 1559, and afterwards with the Greek in 1580, folio. His life was written by Porphyry, the moſt illuſtrious of his diſciples.

Plotus.

PLOTUS, or Darter, in ornithology, a genus of birds

Plotus. birds belonging to the order palmipedes. The bill is long and ſharp-pointed; the noſtrils are merely a long ſlit placed near the baſe; the face and chin are bare of feathers; the neck is very long; and the legs are ſhort. They have four toes webbed together. There are three ſpecies of this genus, and three varieties of the ſecond of theſe.

1. The plotus anhinga, or white-bellied darter, is not quite ſo big as a mallard; but its length from the point of the bill to the end of the tail is 10 inches. The bill, which is three inches long, is ſtraight and pointed: the colour is greyiſh, with a yellowiſh baſe: the irides are of a gold colour: the head is ſmall: the neck long and ſlender: the upper part of the back and ſcapulars are of a duſky black colour; the middle of the feathers are daſhed with white: the lower part of the back, &c. are of a fine black colour: the under parts from the breaſts are ſilvery white: the ſmaller wing coverts, and thoſe in the middle, are duſky black; the larger ones are ſpotted with white, and the outer ones are plain black: the tail feathers are 12 in number, broad, long, and gloſſy black: the legs and toes are of a yellowiſh grey. This ſpecies is an inhabitant of Braſil, and is exceedingly expert and cunning in catching fiſh. Like the corvorant, it builds neſts on trees, and rooſts in them at night. It is ſcarcely ever ſeen on the ground, being always on the higheſt branches of trees on the water, or ſuch as grow in the moiſt ſavannas or river ſides. When at reſt, it generally ſits with the neck drawn in between the ſhoulders like the heron. The fleſh is in general very fat; but has an oily, rank, and diſagreeable taſte like that of a gull.

2. The anhinga of Cayenne, or black-bellied anhinga, is as large as a common duck, with a very long neck, and a long ſharp-pointed ſtraight bill. The upper part of the bill is of a pale blue, and the lower is reddiſh: the eyes are very piercing: the head, neck, and upper part of the breaſt are light brown: both ſides of the head, and the upper part of the neck, are marked with a broad white line: the back, ſcapulars, and wing coverts, are marked with black and white ſtripes lengthwiſe in equal portions: the quill feathers, the belly, thighs, and tail, are of a deep black colour; the tail is very long and ſlender: the legs and feet are of a pale green colour; and the four toes, like thoſe of the corvorant, are united by webs. This ſpecies is found in the iſlands of Ceylon and Java. They generally ſit on the ſhrubs that hang over the water; and, when they ſhoot out their long ſlender necks, are often taken for ſerpents at firſt ſight.

Mr Latham deſcribes three varieties of this ſpecies, which are all equal in ſize to the common birds of the ſpecies. The firſt and the ſecond variety, which laſt Mr Latham calls the black darter, inhabit Cayenne; and third, or rufous darter, inhabits Africa, particularly Senegal, where it is called *kandar*.

3. The Surinam darter is about 13 inches long, being about the ſize of a teal. The bill is of a pale colour, and about $1\frac{1}{2}$ inch in length: the irides are red: the crown of the head is black, and the feathers behind form a ſort of creſt: the neck, as in the other ſpecies, is long and ſlender: the cheeks are of a bright bay colour: from the corner of each eye there comes a line of white: the ſides and back part of the neck are marked with longitudinal lines of black and white: the wings are black, and the tail is duſky brown: it is alſo tipped with white and ſhaped like a wedge: the breaſt and belly are white: the legs ſhort, but very ſtrong, and of a pale duſky colour: the four toes are joined by a membrane, and barred with black. This ſpecies inhabits Surinam, frequenting the ſides of rivers and creeks, where it feeds on ſmall fiſh and inſects, eſpecially on flies, which it catches with great dexterity. When domeſticated, which often happens, the inhabitants call it the *ſun bird*. Authors have differed exceedingly concerning the genus to which this ſpecies belongs, ſince it is found to differ from the others in ſome pretty eſſential characters: it agrees, however, in ſo many, and thoſe the moſt eſſential, as ſufficiently to excuſe thoſe naturaliſts who claſs it with the plotus genus. See *Latham's Synopſis of Birds*, vol. iii. part 2. p. 627.

Plough.

1 The plough. PLOUGH, in agriculture: A machine for turning up the ſoil by the action of cattle, contrived to ſave the time, labour, and expence, which, without this inſtrument, muſt have been employed in digging the ground, and fitting it for receiving all ſorts of ſeed. See AGRICULTURE, n° 83—95.

Amidſt all the varieties which can occur in the manner of ploughing the ground, ariſing from difference of ſoil, local habits, and other cauſes, there is ſtill a ſameneſs in the taſk which gives a certain uniformity to the chief parts of the inſtrument, and ſhould therefore furniſh principles for its conſtruction. There is not, perhaps, any invention of man that more highly merits our utmoſt endeavours to bring it to perfection; but it has been too much neglected by thoſe perſons who ſtudy machines, and has been conſidered as a rude tool, unworthy of their attention. Any thing appears to them ſufficient for the clumſy taſk of turning up the ground; and they cannot imagine that there can be any nicety in a buſineſs which is ſucceſsfully performed by the ignorant peaſant. Others acknowledge the value of the machine, and the difficulty of the ſubject; but they think that difficulty inſuperable, becauſe the operation is ſo complicated, and the reſiſtances to be overcome ſo uncertain, or ſo little underſtood, that we cannot diſcover any unequivocal principle, and muſt look for improvement only from experience or chance. 2 An inſtrument of the greateſt value.

But theſe opinions are ill founded. The difficulty is indeed great, and it is neither from the ignorant farmer nor the rude artiſt that we can expect improvement. It requires the ſerious conſideration of the moſt accompliſhed mechanician; but from him we *may* expect improvement. We have many data: we know pretty diſtinctly what preparation will fit the ground for being the proper receptacle for the ſeed, and for ſupporting and nouriſhing the plants; and though it is, perhaps, impoſſible to bring it into this ſtate by the operation of any inſtrument of the plough kind, we know that ſome ploughs prodigiouſly excel others in reducing the ſtiff ground to that uniform crumbling ſtate in which it can be left by the ſpade. The imperfections of their performance, or what yet remains to be done to bring the ground into this ſtate, is diſtinctly underſtood. It ſeems, then, a determinate problem (to uſe the language of mathematicians), becauſe the operation depends on the invariable laws of mechanical nature. 3 And may be improved.

It will therefore be very proper, under this article, to aſcertain, if poſſible, what a plough in general ought to be, by deſcribing diſtinctly its taſk. This will ſure- 4 The taſk it performs.

ly point out a general form, the chief features of which muſt be found under every variety that can ariſe from particular circumſtances.

The plough performs its taſk, not by digging, but by being pulled along. We do not aim at immediately reducing the ground to that friable and uniform ſtate into which we can bring it by the ſpade; but we wiſh to bring it into ſuch a ſtate that the ordinary operations of the ſeaſon will complete the taſk.

For this purpoſe, a ſlice or ſod muſt be cut off from the firm land. This muſt be ſhoved to one ſide, that the plough and the ploughman may proceed in their labour; and the ſod muſt be turned over, ſo that the graſs and ſtubble may be buried and rot, and that freſh ſoil may be brought to the ſurface; and all muſt be left in ſuch a looſe and open condition, that it may quickly crumble down by the influence of the weather, without baking into lumps, or retaining water. The firſt office is performed by the coulter, which makes a perpendicular cut in the ground. The point of the ſock follows this, and its edge gets under the ſod, and lifts it up. While lifting it up, it alſo heels it over, away from the firm land. The mould-board comes laſt, and puſhes it aſide, and gradually turns it over as far as is required.

Plate CCCXCVIII.

5 General form of the plough.

The general form of the body of a plough is that of a wedge, or very blunt chiſſel, AFEDBC, (fig. 1.), having the lower corner D of its edge conſiderably more advanced than the upper corner B; the edge BD and the whole back AFDB is in the ſame perpendicular plane; the bottom FDB approaches to a triangular form, acute at D, and ſquare at F; the ſurface BCED is of a complicated ſhape, generally hollow, becauſe the angle ABC is always greater than FDE: this conſequence will be eaſily ſeen by the mathematician. The back is uſually called the LAND SIDE by the ploughmen, and the baſe FDE is called the SOLE, and FE the HEEL, and BCED the mould-board. Laſtly, the angle AFE is generally ſquare, or a right angle, ſo that the ſole has level both as to length and breadth.

6 Advantages of this form.

By comparing this form with attention, the reader will perceive that if this wedge is pulled or puſhed along in the direction FD, keeping the edge BD always in the perpendicular cut which has been previouſly made by the coulter, the point D will both raiſe the earth and ſhove it to one ſide and twiſt it over; and, when the point has advanced from F to D, the ſod, which formerly reſted on the triangle DFE, will be forced up along the ſurface BCED, the line DF riſing into the poſition D*f*, and the line EF into the poſition E*f*.—Had the bottom of this furrow been covered with a bit of cloth, this cloth would be lying on the mould-board, in the poſition D*f*E: the ſlice, thus deranged from its former ſituation, will have a ſhape ſomething like that repreſented in fig. 2.

In as much as the wedge raiſes the earth, the earth preſſes down the wedge; and as the wedge puſhes the earth to the right hand, the earth preſſes the wedge to the left; and in this manner the plough is ſtrongly preſſed, both to the bottom of the furrow by its ſole, and alſo to the firm land by its back or land-ſide. In ſhort, it is ſtrongly ſqueezed into the angle formed along the line FD (fig. 1.) by the perpendicular plane *a b* DF and the horizontal plane FDE; and in this manner the furrow becomes a firm groove, directing the motion of the plough, and giving it a reſiſting ſupport, by which it can perform all parts of its taſk. We beg our readers to keep this circumſtance conſtantly in mind. It evidently ſuggeſts a fundamental maxim in the conſtruction, namely, to make the land-ſide of the plough an exact plane, and to make the ſole, if not plane, at leaſt ſtraight from point to heel. Any projection would tear up the ſupporting planes, deſtroy the directing groove, and expend force in doing miſchief.

7 A fundamental maxim in the conſtruction of a plough.

This wedge is ſeldom made of one piece. To give it the neceſſary width for removing the earth would require a huge block of timber. It is therefore uſually framed of ſeveral pieces, which we ſhall only mention in order to have the language of the art. Fig. 3. repreſents the land-ſide of a plough, ſuch as are made by James Small at Roſebank, near Foord, Mid Lothian. The baſe of it, CM, is a piece of hard wood, pointed before at C to receive a hollow ſhoeing of iron CO, called the SOCK, and tapering a little towards the hinder end, M, called the HEEL. This piece is called the HEAD of the plough. Into its fore part, juſt behind the ſock, is mortiſed a ſloping poſt, AL, called the SHEATH, the front of which is worked ſharp, forming the edge of the wedge. Nearer the heel there is mortiſed another piece, PQ, ſloping far back, called the STILT, ſerving for a handle to the ploughman. The upper end of the ſheath is mortiſed into the long BEAM RH, which projects forward, almoſt horizontally, and is mortiſed behind into the ſtilt. To the fore end of the beam are the cattle attached. The whole of this ſide of the wedge is faſhioned into one plain ſurface, and the intervals between the pieces are filled up with boards, and commonly covered with iron plates. The COULTER, WFE, is firmly fixed by its ſhank, W, into the beam, rakes forward at an angle of 45° with the horizon, and has its point E about ſix inches before the point of the ſock. It is brought into the ſame vertical plane with the land-ſide of the plough, by giving it a knee outward immediately below the beam, and then kneeing it again downward. It is further ſupported on this ſide by an iron ſtay FH, which turns on a pin at F, paſſes through an eye-bolt I on the ſide of the beam, and has a nut ſcrewed on it immediately above. When ſcrewed to its proper ſlope, it is firmly wedged behind and before the ſhank.—Fig. 3. N° 2. repreſents the ſame plough viewed from above. ST is the right hand or ſmall ſtilt fixed to the inſide of the mould-board LV.

8 The ſeveral parts of the plough.

Fig. 4. repreſents the bottom of the wedge. CM is the head, covered at the point by the ſock. Juſt behind the ſock there is mortiſed into the ſide of the head a ſmaller piece DE, called the wreſt, making an angle of 16° with the land-ſide of the head, and its outſide edge is in the ſame ſtraight line with the ſide of the ſock. From the point to the heel of the head is about 33 inches, and the extreme breadth of the heel is about nine. The ſide of the wedge, called the furrow ſide, is formed by the mould-board, which is either made of a block or plank of wood, or of a thick iron plate.

The ſock drawn in this figure is called a SPEAR SOCK, and is chiefly uſed in coarſe or ſtony ground, which requires great force to break it up. Another form of the ſock is repreſented in the next figure 4. N° 2. This is called a FEATHER SOCK, and has a cutting edge CF on its furrow ſide, extending back about ten inches, and to the right hand or furrow ſide about ſix. The uſe 9 Socks.

4

Plough. ufe of this is to cut the fod below, and detach it from the ground, as the coulter detaches it from the unploughed land. This is of great ufe when the ground is bound together by knotted roots, but it is evident that it cannot be ufed to advantage in very ftony ground. In general, the feather fock is only fit for ground which has been under tolerable culture; but it greatly facilitates the labour of feparating the fod. It may reafonably be afked, why the feather is not much broader, fo as to cut the whole breadth of the furrow? This is fometimes done. But we muft recollect that the fod is not only to be pufhed afide, but alfo to be turned over. If it were completely detached by the feather, and chanced at any time to break on the back of the fock, it would only be pufhed afide; but by leaving a little of the fod uncut, it is held faft below while it is fhoved afide above, which cannot fail to twift it round. As the wreft advances, it eafily deftroys the remaining connection, which in general is very flight and crumbling.

10 Proper breadth of the fole. The breadth of the fole at the heel determines the width of the furrow. Nine inches will give enough of room for a horfe or man to walk in. A greater breadth is of no ufe, and it expends force in pufhing the earth afide. It is a miftake to fuppofe that a broad fole gives more room for the turned flice to ftand on; for whatever is the breadth of the furrow, the fucceffive flices will be left at their former diftances, becaufe each is fhoved afide to the fame diftance. When the breadth of a flice exceeds its depth, and it is turned on its fide, it will now ftand on a narrow bafe, but higher than before, and therefore will ftand loofer, which the farmers defire. But in this cafe it generally falls on its back before it has been far enough removed, and is then pufhed afide, and left with the graffy fide down, which is not approved of. On the other hand, when the depth confiderably exceeds the breadth, the fods, now turned on their fides, muft be fqueezed home to the ploughed land, which breaks them and toffes them up, making rough work. In wet clay foil, this is alfo apt to knead them together. On the whole, it is beft to have the breadth and depth nearly equal. But all this is workmanfhip, and has no dependence on the width of the fole behind.

11 Should be level. We have already faid that the fole is generally level from right to left at the heel. This was not the cafe formerly, but the wreft was confiderably raifed behind. It refulted from this form, that the furrow was always fhallower on the right fide, or there was left a low ridge of unftirred earth between the furrows. This circumftance alone was a bad practice; for one great aim of ploughing is the renewal of the fuperficial foil. In this way of ribbing the furrows, the fod tumbles over as foon as it is pufhed to the top of the rib on the right of the *rut* made by the plough; the firmeft parts of it fall undermoft, and the reft crumbles above it, making the work appear neat; whereas it is extremely unequal, and what moft needs the influence of the weather to crumble it down is fheltered from it. Add to thefe circumftances, that the hollow is a receptacle for water, with a furface which can retain it, having been confolidated by the preffure of the plough. For all thefe reafons, therefore, it feems advifable to form the furrow with a flat or level bottom, and therefore to keep the heel of the wreft as low as the heel of the head. For the fame reafon it is proper to hold the plough with the landfide perpendicular, and not to heel it over to that fide, as is frequently done, producing the fame ribbed furrow as an ill-formed fole. 12

Length of the plough. There is great variety of opinions about the length of the plough. If confidered merely as a pointed inftrument, or even as a cutting inftrument acting obliquely on a given length of fod, there can be no doubt but that it will be more powerful as it is longer; that is, it will require lefs force to pull it through the ground. But it muft alfo fhove the earth afide, and if we double its length we caufe it to act on twice as much earth at once; for when the plough has entered as far as the heel, the whole furrow fide is acting together in pufhing the earth to the fide. Now it is found, that the force neceffary for pufhing a mafs of earth horizontally along the rough ground is nearly equal to its weight. It would feem, therefore, that nothing is to be gained by making the bafe of the plough of a great length, except a greater facility in making the firft penetration, and this is chiefly performed by the coulter and fock; and a great length renders the plough heavy and cumberfome; and, by caufing it to act long on the fod, tends to knead and cake it.

Nothing very precife can be offered on this fubject. Some fenfible advantage is derived by making the plough taper, efpecially forward, where it acts as a boring and cutting inftrument; and for this purpofe it is convenient 13
to give the coulter a flope of 45 degrees. (This has Slope of the coulter and of the feather. alfo the advantage of throwing up the ftones and roots, which it would otherwife drive before it through the firm ground.) And for the fame reafon the edge of the feather has a great flope, it being ten inches long and only fix inches broad. But if we purfue this advantage too far we expofe ourfelves to another rifk. It is fometimes neceffary to heel over the plough to the right in order to get over fome obftruction. In doing this, the coulter is neceffarily raifed for a moment, and the flanting cut now made by the feather becomes the directing groove for the plough. When the feather has a very long flope, this groove has force enough to guide the whole plough; and it is almoft impoffible for the ploughman to prevent it from running out of the ground to the land-fide (A). The feather, therefore, fhould not exceed 10 or 12 inches in length.

But to return to the length of the plough, from which this obfervation has diverted us a little, we muft add, that a long plough has a great advantage in the fteadinefs of its motion, having a much more extenfive fupport both on the land-fide and below, and being therefore lefs affected by its inequalities. Accordingly they are now made confiderably longer than formerly; and 33 inches has been affumed as a proportion to 9 inches of breadth, in conformity to the moft approved ploughs now in ufe.

We come now to treat of the mould-board. This 14 The mould-board is

(A) This is often felt with the excellent plough defcribed by Mr Arbuthnot of Surry, in the Tranfactions of the Society for the Encouragement of Arts, &c. London.

Plough. is the most delicate part of the plough, and is to be seen in the greatest variety in the works of different artists, each of whom has a nostrum of great value in his own opinion. It is here indeed that the chief resistances are exerted and must be overcome; and a judicious form of this part of the plough may diminish them considerably, while it performs the work in the best manner. Without pretending to say that the different resistances are susceptible of an accurate determination, we can still draw sufficient information from palpable rules of mechanics to direct us to what would be nearly the best possible form for a mould-board. The task to be performed is to raise, push aside, and turn over to a certain degree, a slice already cut off from the firm ground. As we cannot provide for every inequality of the cohesion or tenacity of the earth, our safest way is to consider it as uniform: the weight of it is always so. As we cannot provide for every *proportion* between the tenacity and the weight, we must take an average or medium proportion which is not far from that of equality. Conceiving the slice at first as only tenacious, and without weight, it is an easy problem to determine the form which shall give it the intended twist and removal with the smallest force. In like manner we can proceed with a slice that has weight without tenacity. It is equally easy to combine both in any proportion; and it is easiest of all to make this combination on the supposition of equality of weight and cohesion. Supposing the slice like a brick, we know that it requires the greatest force to *begin* to raise it on one edge, and that the strain becomes less as it rises, till its centre of gravity is perpendicularly above the supporting angle. It requires no force to raise it further; for on pushing it beyond this position, it would fall over of itself, unless withheld by the tenacity of what is not yet raised. But on considering the form or plan of the sock, we find that while the weight of the sod resists most strongly, there is less of it in this situation actually rising, and this nearly in the same proportion with the labour of raising it; and we see that after the sod has attained that position in which it is ready to fall over, it has reached the wider part of the wrest, and is now pushed aside, which requires nearly the same force as to raise it: and this continues to the end of the operation.

When we take all these circumstances into consideration, it appears probable, that the compound resistance does not change much from first to last. If this be really the case, it is an undoubted maxim that the whole operation should proceed equably: if it does not, there must be some part of the sod that makes a resistance greater than the medium; and as the resistances in all this class of motions increase nearly as the squares of the velocities with which they are overcome, it is demonstrable that we shall lose power if we render them unequal.

15 How to be formed.

Hence we deduce this maxim, *That as the plough advances through equal spaces, the twist and the lateral sliding of the sod should increase by equal degrees.* And this determines *à priori* the form of the mould-board. This principle occurred to Mr James Small a ploughmaker in Berwickshire, and he published a treatise on the subject in 1784. He has given several methods for constructing mould-boards, which he supposes are in conformity to his principle; but being merely a country artist, and unacquainted with science, his rules do not produce mouldboards having this property of equable operation, altho' they do not deviate far from it. His book is a very useful and instructive performance, and level to the capacity of those for whom it is intended; and we have here availed ourselves of the author's information on many points.

The high character which Small's ploughs have maintained for 25 years is a strong argument for the truth of the maxim. We shall therefore give such instructions as will enable any intelligent workman to construct such a mould-board without any risk of failure; and if future theory or experience should discover any error in the principles from which this maxim is deduced, by showing that either the weight, the tenacity, or the lateral resistance, is exerted according to a different law from what has been assumed, the directions to be given are of such a nature that they adapt themselves with precision to these changes of principle, and will still produce a perfect and efficacious plough. Our readers will readily acknowledge that this is gaining a great point; because at present the instrument is constructed very much at random, and by a guess of the eye.

Let us now return to the wedge formerly made use of for illustrating the action of the plough. Suppose it placed in a furrow already ploughed, and that the space before the line FE (fig. 1.), which is square from the line of motion FD, is covered with a piece of cloth or carpet, and that the point of the wedge enters upon it at F, and advances to D. It will evidently raise the cloth, which will now cover the side of the wedge, forming the triangle *f*DE. The line *f*D is what formerly lay in the angle along the line FD, and *f*E formerly lay on FE. It is this line FE therefore that we are to raise, shove aside, and twist round, by equal degrees, while the plough advances through equal spaces.

Now, if the length DF of the plough-wedge, reckoned from the point of the sock to the heel, be 33 inches, and the breadth FE behind be 9 inches, the angle DEF or DE*f* will be nearly 74°. The construction of the furrow side of the plough is therefore reduced to this very simple problem, "To make the angle DE*f* turn equably round the axis DE, while the angular point E advances equably from D to E."

16 Description of an instrument for this purpose.

This will be done by means of the following very simple tool or instrument. Let IHFK (fig. 5.) be a piece of hard wood, such as oak, a foot long, three inches broad, and an inch thick. Plant on this another piece BHFC of the same breadth, four inches long, and half an inch thick. This will leave beyond it a flat 8 inches long. We shall call this the *stock* of the instrument. Let ABC be a piece of clean oak half an inch thick, 20 inches long, and three inches broad at the end BC. Let this be fashioned like the stile of a sun-dial, having its angle ABC 74°. Let it have a part BCE square, to the extent of four inches from C, and the rest EA worked into the form of a straight slender rod. Let EFG be a semicircle of clean plane-tree or of metal four inches radius: fasten this by small screws to the square part of the stile CE, so that its centre may be at C. Let this semicircle be divided into 180 degrees, and numbered from G along the arch GFE, so that 0° may be at G, and 180° at E. Let this stile and semicircle turn round the line BC by means of small hinges. This instrument may be called the mould-board, gage, or protractor. When the stile is folded down on the stock

Plough. ftock BIK, the point G will be at F; and when it is raifed up to any angle, the degrees will be pointed out on the femicircle by the ftraight edge CF.

Nothing can be more obvious than the manner of employing this inftrument once we have determined the moft proper pofition for the fod when the work is completed. Now it feems to be the opinion of the moft intelligent farmers, that the beft pofition of the fod is that reprefented in fig. 6.

Proper position of the working parts of the plough. Fig. 6. reprefents a fection of the ground and the working parts of the plough, as viewed by a perfon ftanding ftraight before it. ABDC is the unploughed ground, and WB the coulter, kneed in Small's manner. FGKB is the fection of the plough (or rather of the whole fpace through which the plough has paffed, for no part of the plough has this fection). HOFE is the fection of a flice, pufhed afide and turned over, fo as to lean on the next. HE is that fide of the flice which formerly lay on KB. EF is the fide cut off by the coulter; and FO is the upper or graffy fide. The lower corners are fuppofed to be a little bruifed inwards, as muft generally happen.

The fod is pufhed 9 inches to the right hand, and it leans with its graffy fide on the preceding furrow, in an angle of about 50 degrees. In this pofition the grafs is turned down fo as to rot; and there is a hollow left below to allow the rain water to run freely off, and to receive the earth as it crumbles down by the weather: and if the harrow is dragged acrofs thefe ridges, it diftributes along the furface the mould which was formerly at the bottom. The fod has got a twift of 130 degrees: but it is evident, that after it has been turned 90 degrees, or even a little before this, it is ready to fall over of itfelf. It is fufficient therefore that it be turned 90 degrees when the heel of the wreft has reached it, and the remainder of the twift is given to it by the wing or flap of the mould-board. This, then, dictates to us the manner of applying the inftrument.

Divide the edge DE (fig. 7.) of the wreft, or of a lath nailed on it, into 90 equal parts, and continue the divifions backwards to G in the fame line to 130. Number the divifions backwards from the point of the fock; then place the protractor on the edge of the wreft, with the point B of fig. 5. at the 90th divifion (fig. 7.); that is, juft at the heel, with the ftock under the wreft, and the ftile raifed to 90°, and prefs it home to the joint, fo that the ftock may be fquare to the edge, and then the ftile will be in the pofition fuiting that part of the mould-board. In like manner flide the ftock forward to the 80th divifion, and lower the ftyle to 80°, and it will have the pofition which fuits that part of the mould-board. In the fame way flide it forward to 70, 60, 50, &c. and lower the ftile to 70°, 60°, 50°, &c. and we fhall have the pofition for thefe feveral parts of the mould board; and thus it may be formed to the very point of the fock, becaufe the ftraight edge of the wreft may be continued fo far. A block of wood may be hewed to fit thefe feveral pofitions of the protractor ftile; and this, when placed with its ftraight edge on the outer line of the wreft, and cut away behind in the land-fide plane, will be the exact fhape of the plough-wedge. It would rife up indeed into a tall piece of fingular fhape, gradually tapering down to the point of the fock; but when cut off parallel to the ground, at the height of about 12 inches, it will form the mould-board, the front or edge of the fheath, and the whole back of the fock except the feather, which is an extraneous piece. The wing or flap of the mould-board is formed in the fame manner, by fliding the ftock of the protractor to 100, 110, 120, 130, and opening the ftile to 100°, 110°, 120°, 130°. This will extend the top of the mould-board to about 22 or 23 inches; but the lower part of the wing muft be cut away, becaufe it would pufh the fod too far afide after it has got the proper twift. The form of this part fhould be fuch as would exactly apply itfelf to a plank fet at the heel of the wreft, parallel to the land-fide of the head, and leaning outward 40 degrees. This will be very nearly the cafe if it be made a fweep fimilar to the edge of the fheath. Fig. 8. is a refemblance of the furface of the mould-board; AD being the edge of the fheath, E the heel of the wreft, and EBC the wing or flap. When cut through in a perpendicular direction, the fection is hollow; if cut horizontally it is convex; and if in the direction CE, making an angle of 74° with ED, it is ftraight. If the protractor be fet on it at D, and gradually flidden backwards, the mould-board will gradually open the ftile, and the ftile will fkim its whole furface without any vacuity between them.

(margin, left column: 118 How to form the mould-board.)

This form is given to the mould-board on the authority of the fuppofition that the fum of the refiftances arifing from weight and tenacity remains pretty conftant in its whole length. This cannot be affirmed with confidence in any cafe, and is by no means true in all. In ftiff clay foils the effects of tenacity prevail, and in light or crumbling foils the weight is the chief refiftance. The advantage of this mode of conftruction is, that it can be adapted to any foil. If the difficulty of cutting and raifing the fod is much greater than that of fhoving it afide and turning it over, we have only to make the rife and twift more gentle towards the point of the fock, and more rapid as we advance; and it is eafy to do this according to any law of acceleration that we pleafe. Thus, inftead of dividing the edge of the wreft DE (fig. 9.) continued to G into 130 parts, draw a line G*g* perpendicular to it, and draw fome curve line D*g* convex toward DG, and divide this into equal parts in the points 10, 20, 30, 40, &c.; and then draw perpendiculars to the wreft edge, cutting it in 10, 20, 30, 40, &c. and apply the protractor to thefe points. It is evident that the divifions of the wreft line are bigger at D, and grow gradually lefs towards G; and therefore, becaufe each has 10° more twift than the preceding, the twift will be more rapid as it approaches the end of the mould-board. This curve may be chofen fo as to produce any law of acceleration. On the contrary, we produce a retarded or diminifhed twift by making the curve concave towards DG, as reprefented by the dotted curve.

The mathematical reader will obferve, that this conftruction aims at regulating the twift round the line of the wreft ED. This does not produce precifely the fame regulation round the line FD, which is the line of the plough's motion, and of the fod's pofition before it is ploughed over. The difference, however, is not worth attending to in a matter fo little fufceptible of precifion. But the twift round the line FD may be regulated according to any law by this inftrument with equal facility. Inftead of placing the ftock of the protractor fquare with the edge of the wreft, it may be placed

ſquare with the land-ſide of the plough. To do this, draw a line BL (fig. 5. nº 2.) acroſs the ſtock from the point B, making the angle LBC 16°, and put a braſs pin at L, making a hole in the ſtyle that it may not be prevented from folding down. Then in uſing the inſtrument let the points B and L reſt againſt the edge of the wreſt, and proceed as directed.

A ſtill greater variety of forms, and accommodation to particular views, with the ſame general dependence on principle, will be procured by giving the rod BA a motion round B in the plane of the ſtile, ſo as to form a ſtile of a variable angle.

A tool may even be conſtructed in which the rod BA might be a cutting knife: and the whole may be led along by a ſcrew, while this knife turns round according to any law, and would gradually pare away the mould-board to the proper form.

Thus have we reduced the faſhioning the operative part of the plough to a rule which is certain. We do not mean by this, that a mould-board made according to the maxim now given will make the beſt poſſible plough; but we have given a rule by which this part of the plough can be made unequivocally of a certain quality by every workman, whatever this quality may be, and this without being obliged to copy. No deſcription of any curve mould-board to be met with in books has this advantage; and we ſay that this rule is capable of any ſyſtematic variation, either with reſpect to the width of furrow, or the quantity or variation of its twiſt. We have therefore put it in the power of any intelligent perſon to make ſuch gradual and progreſſive changes as may ſerve to bring this moſt uſeful of all inſtruments to perfection. The angle of the head and wreſt, and the curve for dividing the wreſt line, can always be expreſſed in writing, and the improvements communicated to the public at large.

19 Mode of the plough's action.

After this deſcription of the working parts of a plough, and directions for giving it the moſt effective form, it will not be improper to conſider a little its mode of action, with the view of attaining a more diſtinct conception of what is done by the ploughman and the cattle, and to direct him in his procedure.

Returning again to the wedge (fig. 1.), we ſee that it is preſſed down at the point D, and as far back along the mould-board as its ſurface continues to look upward, that is, all the way to the heel of the wreſt. Behind this, the perpendicular ſections of the mould-board overhang, and look downward; and here, while preſſing down the ſod, the plough is preſſed upwards. Theſe two preſſures tend to twiſt the plough round a tranſverſe line ſomewhere between the heel and the point. The plough therefore tends to riſe at the heel, and to run its point deeper into the ground. Upon the whole, the preſſure downwards is much greater than the upward preſſure. It is exerted over a much greater ſpace, and is greater in moſt parts of that ſpace. Behind, very little downward preſſure is neceſſary, the ſod being ready to fall down of itſelf, and only requiring a gentle touch to lay it in a proper poſition.

In like manner the plough is preſſed backward by the reſiſtance made to the coulter and ſock, and part of the reſiſtance made to the ſloping ſide of the mould-board: and it is preſſed to the left by the other part of the preſſure on the ſock and mould-board.

All theſe preſſures muſt be balanced by the joint action of the cattle, the reſiſtance of the bottom, and the reſiſtance of the firm ground on the left hand or land-ſide.

It is the action of the cattle, exerted on that point to which they are attached, which produces all theſe preſſures. It is demonſtrated by the principles of mechanics, that this force muſt not only be equal to the mean or compound force of theſe reſiſting preſſures, but muſt alſo be in the oppoſite direction.

It is further demonſtrated, that if a body be dragged through any reſiſting ſubſtance by a force acting on any point G, and in any direction whatever GH, and really moves uniformly in that direction, the force exerted exactly balances the reſiſtances which it excites, both as to quantity and direction: And if the body advances without turning round the point by which it is dragged, the reſiſtances on one ſide of this point are in equilibrio with thoſe on the oppoſite ſide.

And, laſtly, it is demonſtrated, that when this equilibrium is obtained, it is indifferent to what point in the line GH the force is applied. Therefore, in fig. 3. nº 1. the force acting in the direction HO may either be applied to the point of the beam H, or to the point N of the coulter, or to the point O of the ſock.

When therefore a plough advances ſteadily, requiring no effort of the ploughman to direct it, if the line of draught OM (fig. 10.) be produced backwards to the point G of the mould-board, that point is the place round which all the reſiſtances balance each other. This point may be called the *centre of reſiſtance* and the *centre of action*.

It would be of importance to determine this point by principle; but this can hardly be done with preciſion even in a plough of a known form: and it is impoſſible to do it in general for all ploughs, becauſe it is different in each. It even varies in any plough by every variation of the proportion between the weight and the coheſion of the ſod. We ſee how it can be found experimentally in any given uniform ſod, viz. by producing backwards the line of draught. Then, if the draught-rope, inſtead of being fixed to the muzzle of the beam, were fixed to this point, and if it were pulled in the ſame direction, the plough would continue to perform its work without any aſſiſtance from the ploughman, while the ſod continued uniform. But the ſmalleſt inequality of ſod would derange the plough ſo as to make it go entirely out of its path. Should the reſiſtances between G and D prevail, the plough would go deeper, which would increaſe the reſiſtances on that ſide where they already exceed, and the plough would run ſtill deeper. Should the reſiſtances behind G prevail, the heel would be preſſed down, and the point would riſe, which would ſtill farther deſtroy the equilibrium, and, producing a greater deviation from the right path, would quickly throw the plough out of the ground.

For theſe reaſons we muſt not think of attaching the draught to the centre of reſiſtance; but muſt contrive a point of draught ſuch as ſhall reſtore the plough to its proper poſition when it has been driven out of it by any obſtruction.

20 Muzzle of the beam

The muzzle or end of the beam is a point which will completely ſuit our purpoſe. For ſuppoſe that the reſiſtance

ſiſtance on the back of the ſock has prevailed, and the plough MNFD (fig. 10.) has taken the poſition *m nfd* repreſented by the dotted lines, the draught line GMO is brought down into the poſition *gmo*, diverging a little from GMO, and meeting the mould-board in a point *g* conſiderably before G. By this means the reſiſtances on the hinder ſide of *g* are increaſed, and thoſe before it are diminiſhed, and the plough quickly regains its former poſition.

From theſe obſervations it is plain, that whatever is the ſituation of the centre of reſiſtance, the point of draught may be ſo choſen that the action of the cattle ſhall be directly oppoſed to the reſiſtance of the ground, and that moreover the plough ſhall have no tendency either to go deeper or to run out. This is the uſe of the apparatus at the point of the beam called the muzzle, repreſented at H (fig. 3.) It turns round a bolt *i* through the beam, and can be ſtopped at any height by another pin *k* put through the holes in the arch *l m*. A figure is given of the muzzle immediately below, as it appears when looking down on it. The eye to which the draught-rope is hooked is ſpread out horizontally, as ſhown by HK, and has ſeveral notches O in it, to either of which the hook can be applied. This ſerves to counteract any occaſional tendency which the plough may have to the right or left.

When the plough goes on ſteadily, without any effort of the ploughman, it is ſaid to be in trim, and to ſwim fair; the preſſure before and behind the centre of action being in equilibrio with each other. In order to learn whether a plough will be in this manner under management, hook the draught-rope as high as poſſible. In this ſtate the plough ſhould have a continual tendency to riſe at the heel, and even to run a little into the ground. Then hook the rope as low as poſſible. The plough ſhould now preſs hard on the furrow with the heel, and have ſome tendency to run out of the ground. If both theſe are obſerved, the plough is properly conſtructed in this reſpect; if not, it muſt be altered, either by changing the poſition of the ſock or that of the beam. Lowering the end of the beam will correct the tendency of the plough to go deeper; the raiſing the point of the ſock will alſo have the ſame effect. But it is of conſiderable importance not to take the point of the ſock out of the plane of the ſod, and it is much better to make the alteration by the beam. The ſlope of the coulter has a conſiderable effect, but it cannot be placed very far from the inclination of 45° without the riſk of choaking the plough by driving the roots and ſtones before it. It is of great conſequence to have the coulter ſit exactly in the direction of the plough's motion: if it is in any other direction, it will powerfully twiſt the plough into its own track. As it muſt be fixed in the middle of the beam's thickneſs to have ſtrength, it is removed a little from the plane of the land-ſide, and it was the uſual practice to point it to the left below to compenſate for this; but this by no means removes the diſpoſition to twiſt, and it expoſes to the riſk of catching a ſtone between its point and that of the ſock, which muſt now be driven forward through the firm ground at a great expence of labour to the cattle. Mr Small has very ingeniouſly remedied this by giving the coulter a ſhort knee to the left immediately below the beam, and thus pointing it downwards in the plumb of the land-ſide. See fig. 6.

It is not without its uſe to know the abſolute force neceſſary for tilling the ground. This has been frequently meaſured with a ſpring ſteel-yard. One of Small's ploughs, worked by two horſes, and employed in breaking up ſtiff land which had been ploughed before winter, and much conſolidated by the rains, required a force of 360 lbs. avoirdupois; and we may ſtate this as the ordinary rate of ſuch work; but moderately firm ſod, under good culture, requires at a medium 320 lbs.

As we wiſh to embrace every opportunity of rendering this work uſeful to the public, we ſhall conclude this article with an account of a plough which has juſt now been recommended to public notice by the Scots Highland Society as extremely proper for a hilly country. The inventor, the Rev. Alexander Campbell miniſter at Kilcalmonell in Argyleſhire, was honoured with the Society's gold medal, value L. 25. 21

The Argyleſhire plough.

A, the ſock (fig. 11.); the land-ſide of which ſupplies the place of the coulter, and the ſole of it ſerves for a feather; it is 18 inches long, and is made of a plate of iron 12 inches broad when finiſhed, and ſomewhat under half an inch thick.—B, the head; to be made of iron in a triangular form, 4 inches broad by 2 inches at the thickeſt part. There are 5 inches of the head fixed in the ſock.—C, the beam, 4 inches thick by 5 inches deep, gradually tapered thinner; the length 6 feet.—E, the ſheath, muſt be of the ſame thickneſs with the beam above and the head below, and is five inches broad. An iron ſcrew-bolt connects the beam and head behind the ſheath.—F, the handles are ſo made that the ſlope of the mould-board, which is fixed to one of them, may be the longer and more gradual. They are 5 feet 8 inches long, and 2 feet 4 inches aſunder at the ends.—G, the mould-board, conſiſts of 7 rounded ſticks 2 inches in diameter; the covert of them is in the plane of the ſole, the reſt in ſucceſſion cloſe to each other above it. This makes the mould-board 14 inches broad. To prevent any earth from getting over the mould-board, a thin dale 4 or 5 inches broad is fixed above it. The mould-board, land-ſide, and ſole of the plough, are clad with iron.—The length is 20 inches: this added to 18 inches, the length of the ſock, makes the length from point to heel 3 feet 2 inches.—The muzzle or bridle OPH is alſo of a more convenient and better conſtruction than thoſe commonly in uſe. By means of the ſcrew-pins at L and M different degrees of land may be given to the plough; the iron rod LH being thereby moved ſidewiſe in the ſocket LN, and up and down by OP. The rod is 30 inches long, one broad, and half an inch thick. It is hooked into a ſcrew-bolt at H. Two inches of the rod project at N, in the form of an eye, before the muzzle, to receive the hook of the croſs-tree.

The advantages of this plough are ſaid to be: It is not ſo liable to be interrupted or turned out of its courſe by ſtones, roots, &c. as other ploughs are; nor does it dip ſo deep as to be liable to be broken by large ſtones or flags. The motion of the muzzle is alſo thought an improvement. Another advantage it has over other ploughs is, its not being ſo liable to be choaked up by ſtubble, &c. This we underſtand to be its chief excellency, and an object much deſired in the conſtruction of the plough. Upon the whole, we are informed that this plough is lighter, leſs expenſive, and leſs liable to go

go out of trim than the ordinary plough, and that with it two horses can plough land which require four with any other plough.

24 Objections to its construction.

Such are said to be the advantages of this construction; but we cannot help expressing our apprehension that the uniting the coulter and feather at the point of the sock will expose the plough to great risks of being put out of order. When the upright edge strikes a stone obliquely, especially on the land-side, it must be violently twisted round the point of the head; and, having but a moderate thickness at this part, may be broken or permanently twisted. The plough will then be continually running out of its direction: and we apprehend that this defect cannot be amended without taking off the sock and putting it in the fire. When a coulter is bent by the same cause, the ploughman can either rectify it by altering the wedging, or he can straighten it in the field; and it must be observed, that the plough opposes much less resistance to the derangement of this sort of coulter than of the common one. In the common coulter the strain does not so much tend to twist the plough round the line of its motion, as to press it wholly to landward. The resistance to this is great; but a very moderate force will twist it round its line of motion. In either case, if the blow be given in that point of the coulter where the draught line crosses it, there will be no twist of the whole plough, but the point of the plough will be forced horizontally to or from the land. When the blow is out of this line, the strain tends to twist the beam or the plough. Experience will determine which of the two is the most hazardous. These ploughs are made by Thomas Lindsay, Abbeyhill, Edinburgh, and models are to be seen in the hall of the Highland Society.

Plough-drill. See *Drill sowing*, and Agriculture, p. 318; and Plate VII. and 2d Plate VII. In the Gentleman's Magazine for July 1793, p. 602, Mr Wickins of Pondhead Lodge, New Forest, gives an account of a simplified drill-plough invented by himself. Its importance is increased, he thinks, by the cheapness and easy construction of it, because it can be used upon a small scale by a single man, and upon a larger scale by two men, or a man and boy; so that the inconvenience suffered by horses trampling the ground, &c. is hereby avoided. To the drill for sowing is occasionally annexed a blade for hoeing between the rows: "the good effects of which (says Mr Wickins) are no less obvious from its nurturing the growth of the corn, and producing collateral shoots from the application of fresh soil, but also from its affording the means of extirpating the weeds which are so obnoxious to it." He informs us likewise, that his single hand-drill hath been seen and approved by the Bath Society; and they have in consequence been pleased to vote him an honorary and corresponding member. Since that time, however, he says, he has very materially improved and simplified it. Mr Wickins's description of his invention is far from being accurate; and the drawing, of which there is an engraving in the same magazine, was taken when his machine was in its infant and less improved state. He promises, however, further information in the Gentleman's Magazine, and he offers more particulars to such agricultural people as shall desire it. We are far from decidedly thinking that this plough-drill is a real improvement, or that it ever will come to be really and generally useful. We have seen so many of these and such like improvements make a great noise for a while, and then fall into neglect, without having ever come into use, as makes us shy in forming opinions respecting the utility of those instruments which are so often and so boldly obtruded on the world as the *ne plus ultra* of improvements in their several spheres. We think it our duty, however, to give every attempt at improvement, especially in the useful arts, all the justice in our power; and, on this account, it has always been our custom to lay before our readers such claims to it as have occurred in the course of our work, whether those claims appeared to ourselves to be just or not.

PLOUGHMAN, the person who guides the plough in the operation of tilling.

PLOUGHING, in agriculture, the turning up the earth with a plough. See Agriculture, Part II. *passim*.

PLOVER, in ornithology, a species of Charadrius.

These birds usually fly in exceedingly large flocks in the places they frequent; people talk of 20,000 or 30,000 being seen in a flock. They generally come to us in September, and leave us about the end of March. In cold weather they are found very commonly on lands lying near the sea in quest of food; but in thaws and open seasons they go higher up in the country.

They love to feed on ploughed lands, but never remain long at a time on them, for they are very cleanly in their nature; and the dirt which lodges on their beaks and feet give them so much uneasiness, that they fly to the nearest water to wash themselves. When they roost, they do not go to trees or hedges; but sit squatting on the ground like ducks or geese, far from trees or hedges, when the weather is calm; but when it is stormy, they often get under shelter. In wet weather they do not sleep in the night at all, but run about picking up the worms as they crawl out of the ground; during this feeding they are continually making a small cry, that serves to keep them together; and in the morning they take flight. If in their flight they spy any others on the ground, they call them up; and if they refuse to come, the whole body descends to see what food there is in the place that detains them.

Plovers are very easily taken at the time of their first coming over, when they have not got any other birds mixed among them; but when they afterwards pick up the teal and other shy birds among them, it becomes more difficult. The best season for taking them is in October, especially in the beginning of that month: after this they grow timorous, and are not easily taken again till March, which is the time of their coupling. The severest frosts are not the best season for taking them in nest, but variable weather does better. The north-west wind is found disadvantageous to the taking of them; and in general, great regard is to be paid to the course of the wind in the setting of the nets. All sea-fowl fly against the wind when the land lies that way; and the nets for taking them are therefore to be placed in a proper direction accordingly.

PLOWDEN (Edmund), serjeant at law, was the son of Humphrey Plowden of Plowden in Shropshire, of an ancient and genteel family. He was first a student of the university of Cambridge, where he spent three years in the study of philosophy and medicine.

He then removed to Oxford, where, having continued his former ſtudies about four years more, in 1552 he was admitted to the practice of phyſic and ſurgery: but probably finding the practice of the art of healing leſs agreeable than the ſtudy, he entered himſelf of the Middle Temple, and began to read law. Wood ſays, that in 1557 he was ſummer reader to that ſociety, and Lent-reader three years after, being then ſerjeant and oracle of the law. He died in the year 1584, aged 67; and was buried in the Temple-church, near the north-wall, at the eaſt end of the choir. He married the daughter of William Sheldon of Boley in Worceſterſhire; by whom he had a ſon, who died ſoon after his father. He wrote, 1. Commentaries or Reports of divers Caſes, &c. in the reigns of King Edw. VI. Queen Mary, and Queen Elizabeth; London, 1571, 78, 99, 1613, &c. Written in the old Norman language. 2. Queries, or a Moot-book of caſes, &c. tranſlated, methodized, and enlarged, by H. B. of Lincoln's-Inn; Lond. 1662, 8vo.

PLUCHE (Antony), born at Rheims in 1688, merited by his engaging manners and proficiency in the belles-lettres the appointment of humaniſt in the univerſity of that city. Two years after he obtained the profeſſor of rhetoric's chair, and was admitted into holy orders. The biſhop of Laon (Clermont) informed of his talents, offered him the direction of the college of his epiſcopal city. By his induſtry and ſuperior knowledge, a proper order and ſubordination ſoon took place in it; but ſome particular opinions reſpecting the affairs of the time diſturbed his tranquillity, and obliged him to quit his office. The intendant of Rouen, at the requeſt of the celebrated Rollin, entruſted him with the education of his ſon. Abbé Pluche having filled that place with ſucceſs and great honour to himſelf, left Rouen and went to Paris, where, by the patronage of ſome literary friends and his own excellent writings, he acquired a very diſtinguiſhed reputation for learning. He publiſhed, 1. *Le Spectacle de la Nature* (Nature Diſplayed), in 9 vols in 12mo. This work, which is equally inſtructive and entertaining, is written with perſpicuity and elegance; but the form of dialogue which he adopted has drawn him into the fault of being rather too prolix. The ſpeakers, who are the Prior, the Count, and Counteſs, are not diſtinguiſhed by any ſtriking feature; but they have all the common character, which is tolerably pleaſing, not excepting even that of the little chevalier De Breuil, who is, however, a mere ſcholar. This is the opinion which Abbé Desfontaines has formed of this work. Though the author has given the converſations a pretty ingenious turn, and even ſome vivacity, yet they now and then fall into the tone of the college. 2. *Hiſtoire du Ciel*, or Hiſtory of the Heavens, in 2 vols in 12mo. In this performance we find two parts almoſt independent of one another. The firſt contains ſome learned inquiries into the origin of the poetic heavens. It is nearly a complete mythology, founded upon ideas which are new and ingenious. The ſecond is the hiſtory of the opinions given by philoſophers reſpecting the formation of the world. The author ſhows the inutility, the inconſtancy, and uncertainty, of the moſt eſteemed ſyſtems; and concludes with pointing out the excellence and ſublime ſimplicity of the Moſaic account. Beſides a noble and well-turned expreſſion, we find in it an erudition which does not fatigue the mind. As to the foundation of the ſyſtem explained in the firſt part, though it appears extremely plauſible, we will not take upon us to ſay how far it is true: Voltaire called it *Fable du Ciel*, or a Fable of the Heavens. 3. *De Linguarum artificio;* a work which he tranſlated with this title, *La Mecanique des Langues*, in 12mo. In this treatiſe he propoſes a ſhort and eaſy method of learning languages, which is by the uſe of tranſlations inſtead of themes or exerciſes; and we muſt admit his reflections on that ſubject are both judicious and well expreſſed. 4. Harmony of the Pſalms and the Goſpel, or a Tranſlation of the Pſalms and Hymns of the Church, with Notes relative to the Vulgate, the Septuagint, and Hebrew Text, printed at Paris in 1764, in 12mo. In 1749, Abbé Pluche retired to Varenne St Maure, where he gave himſelf up entirely to devotion and ſtudy. Having become ſo deaf that he could not hear without the help of a trumpet, the capital afforded him very little entertainment. It was in this retreat that he died of an apoplexy on the 20th of November 1761, at the age of 73 years. He poſſeſſed thoſe qualities which form the ſcholar, the honeſt man, and the Chriſtian: temperate in his meals, true to his word, an affectionate parent, a ſenſible friend, and a humane philoſopher; he gave leſſons of virtue in his life as well as in his writings. His ſubmiſſion to all the dogmas of religion was very great. Some Deiſts having been ſurpriſed that, in matters of faith, he ſhould think and ſpeak like the vulgar, his anſwer was, "I glory in doing ſo: It is infinitely more rational to believe the word of God, than to follow the glimmering lights of a reaſon which is limited and ſubject to error."

PLUG, certain pieces of timber, formed like the fruſtum of a cone, and uſed to ſtop the hauſe-holes and the breaches made in the body of a ſhip by cannon-balls; the former of which are called *hauſe-plugs*, and the latter *ſhot plugs*, which are formed of various ſizes in proportion to the holes made by the different ſizes of ſhot, which may penetrate the ſhip's ſides or bottom in battle; accordingly they are always ready for this purpoſe.

PLUKENET (Leonard), a phyſician who flouriſhed in the reign of King Charles II. was one of the moſt excellent and laborious botaniſts of that or any other age. He was author of the *Phytographia Plucenetiana*, the *Almageſticum Britannicum*, and other works of the like kind, on which he ſpent the greateſt part of his life and fortune. His Phytography is mentioned with the higheſt encomiums in the Philoſophical Tranſactions for February 1696-7. His *Opera Botannica*, with cuts, were printed at London in 6 vols folio, in 1720.

PLUM-TREE, in botany. See PRUNUS.

PLUMAGE, the feathers which ſerve birds for a covering. See ORNITHOLOGY, p. 506.

PLUMB-LINE, among artificers, denotes a perpendicular to the horizon; ſo called, as being commonly erected by means of a plummet.

PLUMBAGO, LEAD-WORT; a genus of the monogynia order, belonging to the pentandria claſs of plants. There are four ſpecies; the moſt remarkable of which are the Europæa and Zeylonica. The firſt grows naturally in the ſouthern parts of Europe, and has a perennial root ſtriking deep in the ground. There are many ſlender channelled ſtalks, about three feet high, terminated by tufts of ſmall funnel-ſhaped flowers, of a blue or white colour. The ſecond grows naturally in both

both the Indies. The upper part of the ſtalk and empalement are covered with a glutinous juice, which catches the ſmall flies that light upon it. The former ſpecies is propagated by parting the roots, and by ſeeds; but the latter is too tender to thrive in the open air in this country.

PLUMBAGO. See *Black-Lead*.

PLUMBERY, the art of caſting and working lead, and uſing it in building.

As this metal melts ſoon and with little heat, it is eaſy to caſt it into figures of any kind, by running it into moulds of braſs, clay, plaſter, &c. But the chief article in plumbery is ſheets and pipes of lead; and as theſe make the baſis of the plumber's work, we ſhall here give the proceſs of making them.

In caſting *ſheet-lead*, a table or mould is made uſe of, which conſiſts of large pieces of wood well jointed, and bound with bars of iron at the ends; on the ſides of which runs a frame conſiſting of a ledge or border of wood, three inches thick and four inches high from the mould, called the *ſharps*: The ordinary width of the mould, within theſe ſharps, is from four to five feet; and its length is 16, 17, or 18 feet. This ſhould be ſomething longer than the ſheets are intended to be, in order that the end where the metal runs off from the mould may be cut off, becauſe it is commonly thin or uneven, or ragged at the end. It muſt ſtand very even or level in breadth, and ſomething falling from the end in which the metal is poured in, viz. about an inch or an inch and a half in the length of 16 or 17 feet or more, according to the thinneſs of the ſheets wanted; for the thinner the ſheet, the more declivity the mould ſhould have. At the upper end of the mould ſtands the pan, which is a concave triangular priſm, compoſed of two planks nailed together at right angles, and two triangular pieces fitted in between them at the ends. The length of this pan is the whole breadth of the mould in which the ſheets are caſt; it ſtands with its bottom, which is a ſharp edge, on a form at the end of the mould, leaning with one ſide againſt it; and on the oppoſite ſide is a handle to lift it up by, to pour out the melted lead; and on that ſide of the pan next the mould are two iron-hooks to take hold of the mould, and prevent the pan from ſlipping while the melted lead is pouring out of it into the mould. This pan is lined on the inſide with moiſtened ſand, to prevent it from being fired by the hot metal. The mould is alſo ſpread over, about two inches thick, with ſand ſifted and moiſtened, which is rendered perfectly level by moving over it a piece of wood called a *ſtrike*, and ſmoothing it over with a ſmoothing plane, which is a plate of poliſhed braſs, about one-fourth of an inch thick and nine inches ſquare, turned up on all the four edges, and with a handle fitted on to the upper or concave ſide. The ſand being thus ſmoothed, it is fit for caſting ſheets of lead: but if they would caſt a ciſtern, they meaſure out the bigneſs of the four ſides; and having taken the dimenſions of the front or fore-part, make mouldings by preſſing long ſlips of wood, which contain the ſame mouldings, into the level ſand; and form the figures of birds, beaſts, &c. by preſſing in the ſame manner leaden figures upon it, and then taking them off, and at the ſame time ſmoothing the ſurface where any of the ſand is raiſed up by making theſe impreſſions upon it. The reſt of the operation is the ſame in caſting either ciſterns or plain ſheets of lead. But before we proceed to mention the manner in which that is performed, it will be neceſſary to give a more particular deſcription of the *ſtrike*. The ſtrike, then, is a piece of board about five inches broad, and ſomething longer than the breadth of the mould on the inſide; and at each end is cut a notch about two inches deep, ſo that when it is uſed it rides upon the ſharps with thoſe notches. Before they begin to caſt, the ſtrike is made ready by tacking on two pieces of an old hat on the notches, or by ſlipping a caſe of leather over each end, in order to raiſe the under ſide about one-eighth of an inch or ſomething more above the ſand, according as they would have the ſheet to be in thickneſs; then they tallow the under edge of the ſtrike, and lay it acroſs the mould. The lead being melted, it is put into the pan with ladles, in which, when there is a ſufficient quantity for the preſent purpoſe, the ſcum of the metal is ſwept off with a piece of board to the edge of the pan, letting it ſettle on the ſand, which is by this means prevented from falling into the mould at the pouring out of the metal. When the lead is cool enough, which muſt be regulated according to the thickneſs of the ſheets wanted, and is known by its beginning to ſtand with a ſhell or wall on the ſand round the pan, two men take the pan by the handle, or elſe one of them lifts it by the bar and chain fixed to a beam in the ceiling, and pour it into the mould, while another man ſtands ready with the ſtrike, and, as ſoon as they have done pouring in the metal, puts on the mould, ſweeps the lead forward, and draws the overplus into a trough prepared to receive it. The ſheets being thus caſt, nothing remains but to roll them up or cut them into any meaſure wanted: but if it be a ciſtern, it is bent into four ſides, ſo that the two ends may join the back, where they are ſoldered together; after which the bottom is ſoldered up.

The method of caſting pipes without ſoldering. To make theſe pipes they have a kind of little mill, with arms or levers to turn it withal. The moulds are of braſs, and conſiſt of two pieces, which open and ſhut by means of hooks and hinges, their inward caliber or diameter being according to the ſize of the pipe, uſually two feet and a half. In the middle is placed a core or round piece of braſs or iron, ſomewhat longer than the mould, and of the thickneſs of the inward diameter of the pipe. This core is paſſed through two copper rundles, one at each end of the mould, which they ſerve to cloſe; and to theſe is joined a little copper tube about two inches long, and of the thickneſs the leaden pipe is intended to be of. By means of theſe tubes, the core is retained in the middle of the cavity of the mould. The core being in the mould, with the rundles at its two ends, and the lead melted in the furnace, they take it up in a ladle, and pour it into the mould by a little aperture at one end, made in the form of a funnel. When the mould is full, they paſs a hook into the end of the core, and, turning the mill, draw it out; and then opening the mould, take out the pipe. If they deſire to have the pipe lengthened, they put one end of it in the lower end of the mould, and paſs the end of the core into it; then ſhut the mould again, and apply its rundle and tube as before, the pipe juſt caſt ſerving for a rundle, &c. at the other end. Things being thus replaced, they pour in freſh metal, and repeat the operation till they have got a pipe of the length required.

For

For making pipes of ſheet-lead, the plumbers have wooden cylinders, of the length and thickneſs required; and on theſe they form their pipes by wrapping the ſheet around them, and ſoldering up the edges all along them.

The lead which lines the Chineſe tea-boxes is reduced to a thinneſs which we are informed European plumbers cannot imitate. The following account of the proceſs by which the plates are formed was communicated to a writer in the Gentleman's Magazine by an intelligent mate of an Eaſt Indiaman. The caſter ſits by a pot containing the melted metal; and has two large ſtones, the under one fixed, the upper moveable, directly before him. He raiſes the upper ſtone by preſſing his foot upon the ſide of it, and with an iron ladle pours into the opening a proper quantity of the fluid metal. He then immediately lets fall the upper ſtone, and by that means forms the lead into a thin irregular plate, which is afterwards cut into a proper ſhape. The ſurfaces of the ſtones, where they touch each other, are exactly ground together.

PLUMBUM, LEAD. See LEAD.

Plumbum Corneum, a combination of lead with the marine acid. See CHEMISTRY, n° 812.

PLUME, in botany, the bud or germ. See GEMMA.

PLUMIER (Charles), a learned Minim, born at Marſeilles, and one of the moſt able botaniſts of the 17th century. He was inſtructed by the famous Maignan, who taught him mathematics, turnery, the art of making ſpectacles, burning-glaſſes, microſcopes, and other works. He at length went to Rome to perfect himſelf in his ſtudies, and there applied himſelf entirely to botany under a ſkilful Italian. At his return to Provence, he ſettled in the convent at Bornes, a maritime place near Hieres, where he had the conveniency of making diſcoveries in the fields with reſpect to ſimples. He was ſome time after ſent by the French king to America, to bring from thence ſuch plants as might be of ſervice in medicine. He made three different voyages to the Antilles, and ſtopped at the iſland of St Domingo. The king honoured him with a penſion; and he at laſt ſettled at Paris. However, at the deſire of M. Fagon, he prepared to go a fourth time to America, to examine the tree which produces the Jeſuits bark; but died at the port of Santa Maria, near Cadiz, in 1706. He wrote ſeveral excellent works; the principal of which are, 1. A volume of the Plants in the American Iſlands. 2. A Treatiſe on the American Fern. 3. The Art of Turnery; a curious work embelliſhed with plates.

PLUMMET, PLUMB-*Rule*, or *Plumb line*, an inſtrument uſed by carpenters, maſons, &c. in order to judge whether walls, &c. be upright planes, horizontal, or the like. It is thus called from a piece of lead, faſtened to the end of a chord, which uſually conſtitutes this inſtrument. Sometimes the ſtring deſcends along a wooden ruler, &c. raiſed perpendicularly on another; in which caſe it becomes a level.

PLUMMING, among miners, is the method of uſing a mine-dial, in order to know the exact place of the work where to ſink down an air-ſhaft, or to bring an adit to the work, or to know which way the load inclines when any flexure happens in it.

It is performed in this manner: A ſkilful perſon with an aſſiſtant, and with pen, ink, and paper, and a long line, and a ſun-dial, after his gueſs of the place above ground, deſcends into the adit or work, and there faſtens one end of the line to ſome fixed thing in it; then the incited needle is let to reſt, and the exact point where it reſts is marked with a pen: he then goes on farther in the line ſtill faſtened, and at the next flexure of the adit he makes a mark on the line by a knot or otherwiſe: and then letting down the dial again, he there likewiſe notes down that point at which the needle ſtands in this ſecond poſition. In this manner he proceeds, from turning to turning, marking down the points, and marking the line, till he comes to the intended place: this done, he aſcends and begins to work on the ſurface of the earth what he did in the adit, bringing the firſt knot in the line to ſuch a place where the mark of the place of the needle will again anſwer its pointing, and continues this till he come to the deſired place above ground, which is certain to be perpendicular over the part of the mine into which the air-ſhaft is to be ſunk.

PLUMOSE, ſomething formed in the manner of a feather, with a ſtem and fibres iſſuing from it on each ſide; ſuch are the antennæ of certain moths, butterflies, &c.

PLURAL, in grammar, an epithet applied to that number of nouns and verbs which is uſed when we ſpeak of more than one thing. See GRAMMAR.

PLURALITY, a diſcrete quantity, conſiſting of two or a greater number of the ſame kind: thus we ſay, a plurality of gods, &c. See the article ASTRONOMY, n° 157. for the arguments both for and againſt a plurality of worlds.

Plurality of Benefices, or *Livings*, is where the ſame clerk is poſſeſſed of two or more ſpiritual preferments, with cure of ſouls. See BENEFICE.

The ſmallneſs of ſome benefices firſt gave riſe to pluralities; for an eccleſiaſtic, unable to ſubſiſt on a ſingle one, was allowed to hold two; and at length the number increaſed without bounds. A remedy was attempted for this abuſe at the council of Lateran under Alexander III. and Innocent III. in the year 1215, when the holding more than one benefice was forbid by a canon under the penalty of deprivation; but the ſame canon granting the pope a power to diſpenſe with it in favour of perſons of diſtinguiſhed merit, the prohibition became almoſt uſeleſs. They were alſo reſtrained by ſtatute 21 Hen. VIII. cap. 13. which enacts, that if any perſon having one benefice with cure of ſouls, of the yearly value of 8 l. or above (in the king's books), accept any other with cure of ſouls, the firſt ſhall be adjudged in law to be void, &c. though the ſame ſtatute provides for diſpenſation in certain caſes.

In England, in order to procure a diſpenſation, the preſentee muſt obtain of the biſhop, in whoſe dioceſe the livings are, two certificates of the values in the king's books, and the reputed values and diſtance; one for the archbiſhop, and the other for the lord-chancellor. And if the livings lie in two dioceſes, then two certificates of the ſame kind are to be obtained from each biſhop. He muſt alſo ſhow the archbiſhop his preſentation to the ſecond living; and bring with him two teſtimonials from the neighbouring clergy concerning his behaviour and converſation, one for the archbiſhop and the other for the lord-chancellor; and he muſt alſo ſhow the archbiſhop his letters of orders, and a certificate of his ha-

ving taken the degree of master of arts at the least, in one of the universities of this realm, under the hand of the register. And if he be not doctor or bachelor of divinity, nor doctor nor bachelor of law, he is to procure a qualification of a chaplain, which is to be duly registered in the faculty office, in order to be tendered to the archbishop, according to the statute. And if he hath taken any of the aforesaid degrees, which the statute allows as qualifications, he is to procure a certificate thereof as already mentioned, and to show the same to the archbishop; after which his dispensation is made out at the faculty office, where he gives security according to the direction of the canon. He must then repair to the lord-chancellor for confirmation under the broad seal; and he must apply to the bishop of the diocese where the living lies for his admission and institution. By the several stamp acts, for every skin, or paper, or parchment, &c. on which any dispensation to hold two ecclesiastical dignities or benefices, or a dignity and a benefice, shall be engrossed or written, there shall be paid a treble 40s. stamp duty.

We have also a regulation in regard to pluralities; but it is often dispensed with: for, by the faculty of dispensation, a pluralist is required, in that benefice from which he shall happen to be most absent, to preach 13 sermons every year, and to exercise hospitality for two months yearly.

In Germany the pope grants dispensations for possessing a plurality of benefices, on pretence that the ecclesiastical princes there need large revenues to bear up against the Protestant princes.

PLUS, in algebra, a character marked thus +, used for the sign of addition. See ALGEBRA, p. 400, and *NEGATIVE Sine*.

PLUSH, in commerce, &c. a kind of stuff, having a sort of velvet knap or shag on one side, composed regularly of a woof of a single woollen thread and a double warp; the one wool, of two threads twisted; the other goats or camels hair; though there are some plushes entirely of worsted, and others composed wholly of hair.

PLUTARCH, a great philosopher and historian of antiquity, who lived from the reign of Claudius to that of Hadrian, was born at Chæronea, a small city of Bœotia in Greece. Plutarch's family was ancient in Chæronea: his grandfather Lamprias was eminent for his learning and a philosopher; and is often mentioned by Plutarch in his writings, as is also his father. Plutarch was initiated early in study, to which he was naturally inclined; and was placed under the care of Ammonius, an Egyptian, who, having taught philosophy with great reputation at Alexandria, from thence travelled into Greece, and settled at Athens. Under this master he made great advances in knowledge; and like a thorough philosopher, more apt to regard things than words, he pursued this knowledge to the neglect of languages. The Roman language at that time was not only the language of Rome, but of Greece also; and much more used there than the French is now in England. Yet he was so far from regarding it then, that, as we learn from himself, he became not conversant in it till the declension of his life: and, though he is supposed to have resided in Rome near 40 years at different times, yet he never seems to have acquired a competent skill in it. But this was not the worst: he did not cultivate his mother-tongue with any great exactness; and hence that harshness, inequality, and obscurity in his style, which has so frequently and so justly been complained of.

After he was principled and grounded by Ammonius, having an insatiable thirst for knowledge, he resolved to travel. Egypt was at that time, as formerly it had been, famous for learning; and probably the mysteriousness of their doctrine might tempt him, as it had tempted Pythagoras and others, to go and converse with the priesthood of that country. This appears to have been particularly his business, by his treatise *Of Isis and Osiris*: in which he shows himself versed in the ancient theology and philosophy of the wise men. From Egypt he returned into Greece; and visiting in his way all the academies and schools of the philosophers, gathered from them many of those observations with which he has abundantly enriched posterity. He does not seem to have been attached to any particular sect, but culled from each of them whatever he thought excellent and worthy to be regarded. He could not bear the paradoxes of the Stoics, but yet was more averse from the impiety of the Epicureans: in many things he followed Aristotle; but his favourites were Socrates and Plato, whose memory he revered so highly, that he annually celebrated their birth-days with much solemnity. Besides this, he applied himself with extreme diligence to collect not only all books that were excellent in their kind, but also all the sayings and observations of wise men which he had heard in conversation or had received from others by tradition; and likewise to consult the records and public instruments preserved in cities which he had visited in his travels. He took a particular journey to Sparta, to search the archives of that famous commonwealth, to understand thoroughly the model of their ancient government, the history of their legislators, their kings, and their ephori; and digested all their memorable deeds and sayings with much care. He took the same methods with regard to many other commonwealths; and thus was enabled to leave us in his works such a rich cabinet of observation upon men and manners, as, in the opinion of Montaigne and Bayle, have rendered him the most valuable author of antiquity.

The circumstances of Plutarch's life are not known, and therefore cannot be related with any exactness. According to the learned Fabricius, he was born under Claudius, 50 years after the Christian era. He was married to a most amiable woman of his own native town, whose name, according to the probable conjecture of Rualdus, was Timoxena, and to whose sense and virtue he has borne the most affectionate testimony in his moral works. He had several children, and among them two sons; one called *Plutarch* after himself, the other *Lamprias* in memory of his grandfather. Lamprias was he, of all his children, who seems to have inherited his father's philosophy; and to him we owe the table or catalogue of Plutarch's writings, and perhaps also his apophthegms. He had a nephew, Sextus Chæroneus, who taught the learned emperor Marcus Aurelius the Greek tongue, and was much honoured by him. Some think, that the critic Longinus was of his family; and Apuleius, in the first book of his Metamorphoses, affirms himself to be descended from him.

On what occasion, and at what time of his life, he went

went to Rome, how long he lived there, and when he finally returned to his own country, are all uncertain. It is probable, that the fame of him went thither before him, not only becaufe he had publifhed feveral of his works, but becaufe immediately upon his arrival, as there is reafon to believe, he had a great refort of the Roman nobility to hear him: for he tells us himfelf, that he was fo taken up in giving lectures of philofophy to the great men of Rome, that he had not time to make himfelf mafter of the Latin tongue, which is one of the firft things that would naturally have engaged his attention. It appears that he was feveral times at Rome; and perhaps one motive to his inhabiting there was the intimacy he had contracted in fome of thefe journeys with Soffius Senecio, a great and worthy man, who had been four times conful, and to whom Plutarch has dedicated many of his lives. But the great inducement which carried him firft to Rome, was undoubtedly that which had carried him into fo many other parts of the world; namely, to make obfervations upon men and manners, and to collect materials for writing the lives of the Roman worthies, in the fame manner as he had already written thofe of the Grecian: and accordingly he not only converfed with all the living, but fearched the records of the Capitol, and of all the libraries. Not but, as we learn from Suidas, he was intrufted alfo with the management of public affairs in the empire, during his refidence in the metropolis. "Plutarch (fays he) lived in the time of Trajan, who beftowed on him the confular ornaments, and alfo caufed an edict to be paffed, that the magiftrates or officers of Illyria fhould do nothing in that province without his knowledge and approbation."

When and how he was made known to Trajan is likewife uncertain: but it is generally fuppofed that Trajan, a private man when Plutarch firft came to Rome, was, among other nobility, one of his auditors. It is alfo fuppofed, that this wife emperor made ufe of him in his councils; at leaft, much of the happinefs of his reign has been imputed to Plutarch. Fabricius afferts that he was Trajan's preceptor, and that he was raifed to the confular dignity by him, and made procurator of Greece in his old age by the emperor Adrian. We are equally at a lofs concerning the time of his abode in the imperial city; which, however, at different times, is not imagined to fall much fhort of 40 years. The defire of vifiting his native country, fo natural to all men, and efpecially when growing old, prevailed with him at length to leave Italy: and at his return he was unanimoufly chofen archon or chief magiftrate of Chæronea, and not long after admitted into the number of the Delphic Apollo's priefts. We have no particular account of his death, either as to the manner of it or the year; only it is evident that he lived, and continued his ftudies, to a good old age. The moft probable conjecture is that of Fabricius, who fays he died in the fifth year of Adrian at the age of 70.

His works have been divided, and they admit of a pretty equal divifion, into Lives and Morals: the former of which, in his own eftimation, were to be preferred as more noble than the latter. His ftyle, as we have already obferved, has been excepted to with fome reafon: he has alfo been criticifed for fome miftakes in Roman antiquities, and for a little partiality to the Greeks. On the other hand, he has been juftly praifed for the copioufnefs of his fine fenfe and learning, for his integrity, and for a certain air of goodnefs which appears in all he wrote. His bufinefs was not to pleafe the ear, but to inftruct and charm the mind; and in this none ever went beyond him. Of his moral writings it is to be regretted that we have no elegant Englifh tranflation. Even his Lives were chiefly known to the Englifh reader by a motley and miferable verfion, till a new one executed with fidelity and fpirit was prefented to the public by the Langhornes in 1770. On the whole, it is to be wifhed that this moft amiable moralift and biographer had added a life of himfelf to thofe which he has given to the world of others, as the particulars which other writers have preferved of his perfonal hiftory are very doubtful and imperfect.

PLUTO, in Pagan worfhip, the king of the infernal regions, was the fon of Saturn and Ops, and the brother of Jupiter and Neptune. This deity finding himfelf childlefs and unmarried, mounted his chariot to vifit the world; and arriving in Sicily, fell in love with Proferpine, whom he faw gathering flowers with her companions in the valley of Enna, near mount Ætna; when, forcing her into his chariot, he drove her to the river Chemarus, through which he opened himfelf a paffage back to the realms of night. See Ceres and Proserpine.

Pluto is ufually reprefented in an ebony chariot drawn by four black horfes; fometimes holding a fceptre, to denote his power; at others, a wand, with which he drives away the ghofts; and at others, fome keys, to fignify that he had the keys of death. Homer obferves, that his helmet had the quality of rendering the wearer invifible, and that Minerva borrowed it in order to be concealed from Mars when fhe fought againft the Trojans. Pluto was greatly revered both by the Greeks and Romans, who erected temples and altars to him. To this god facrifices were offered in the night, and it was not lawful to offer them by day.

PLUTUS, in Pagan worfhip, the god of riches, is frequently confounded with Pluto. He was reprefented as appearing lame when he approached, and with wings at his departure; to fhow the difficulty of amaffing wealth, and the uncertainty of its enjoyment. He was alfo frequently reprefented blind, to fhow that he often beftowed his favours on the moft unworthy, and left in neceffity thofe who had the greateft merit.

PLUVIALIS. See Charadrius, n° 7.

PLUVIUS, a furname of Jupiter. He was invoked by that name among the Romans whenever the earth was parched up by continual heat, and was in want of refrefhing rains. He had an altar in the temple on the capitol.

PLYERS, in fortification, denote a kind of balance ufed in raifing or letting down a draw-bridge. They confift of two timber levers, twice as long as the bridge they lift, joined together by other timbers framed in the form of a St Andrew's crofs to counterpoife them. They are fupported by two upright jambs, on which they fwing; and the bridge is raifed or let down by means of chains joining the ends of the plyers and bridge.

PLYING, in the fea language, the act of making, or endeavouring to make, a progrefs againft the direction of the wind. Hence a fhip that advances well in her courfe in this manner of failing, is faid to be a good plyer.

Plymouth. plyer. See the articles BEATING, PITCHING, and TACKING.

PLYMOUTH, a town of Devonſhire, in England, about 215 miles from London, ſtands between the rivers Plym and Tamar, juſt before they fall into the Britiſh Channel. From a mere fiſhing village it has become one of the largeſt towns in the county; and is one of the chief magazines in the kingdom, on account of its port, which is one of the ſafeſt in England, and which is ſo large as to be able to contain 1000 ſail. It is defended by ſeveral different forts, mounting altogether nearly 300 guns; of which the chief is the Royal Citadel, erected in the reign of Charles II. oppoſite to St Nicholas Iſland, which is within the circuit of its walls, and contains a large ſtore-houſe and five regular baſtions. In time of war the outward-bound convoys generally rendezvous at Plymouth, and homeward-bound ſhips generally put in to provide pilots up the Channel. It is alſo a great place of reſort for men of war that are wind-bound.

The mouth of the Tamar is called Ham-Ooze, and that of Plym Catwater, which are both commanded by the caſtle on St Nicholas Iſland. About two miles up the mouth of the Tamar there are four docks, two of which were built in the reign of William III. one wet and the other dry, and two which have been built ſince. They have every conveniency for building or repairing ſhips, and one of them is hewn out of a mine of ſlate and lined with Portland ſtone. This town enjoys a pilchard fiſhery of conſiderable importance, and carries on an extenſive trade with Newfoundland and the Straits. There is a cuſtomhouſe in it; and though there are two churches (and beſides ſeveral meeting-houſes), yet each church has ſo large a cure of ſouls, that the pariſh clerks were till very lately in deacon's orders, to enable them to perform all the occaſional and other offices. The ſeat-rents are given to the poor. The lecturers are choſen every three years by the corporation, which was conſtituted by Henry VI. and conſiſts of a mayor, 12 aldermen, and 24 common-council men. The mayor is elected by a jury of 36 perſons, choſen by four others, two of whom are appointed by the mayor and aldermen, and the other two by the common-council. There is alſo a recorder, and a town-clerk, whoſe place is very profitable. The town conſiſts of four diviſions, which were anciently governed by four captains, each of whom had three conſtables under him. It is well ſupplied with freſh water, which was brought from the diſtance of ſeven miles, by Sir Francis Drake a native of the town. The toll of the markets, and of the cotton, yarn, &c. with the profit of the mill, which is very conſiderable, belongs to the corporation, as do the revenues of the ſhambles, which are farmed out for the mayor's kitchen. There is a charity-ſchool in Plymouth, four hoſpitals, and a workhouſe, in all which 100 poor children are clothed, fed, and taught; and there are two printing-houſes. To one of the hoſpitals Colonel Jory gave a charity for 12 poor widows, as he did a mace worth 120 l. to be carried before the mayor, and ſix good bells, valued at 500 l. to Charles-Church, ſo called from our kings in whoſe reigns it was begun and finiſhed. In the entrance of the bay lies the famous Edyſtone-rock, which is covered at high-water, and on which the ingenious Mr Winſtanley built a light-houſe, that was blown down in the terrible hurricane of Nov. 27th 1703, and himſelf, with others that were with him in it, never more heard of. However, another was erected in the room of it, by the corporation of the Trinity-houſe, in purſuance of an act of the 5th of Queen Anne, which was deſtroyed by an accidental fire Dec. 4th 1755, but rebuilt in 1759: which alſo was burnt down, and rebuilt in the year 1770. In the reign of Edward III. the French landed, and burnt part of the town, but were ſoon repulſed by Hugh Courtenay earl of Devon. In the reign of Henry IV. the French landed here again, and burnt 600 houſes. Between this town and the ſea is a hill called the Haw, which has a delightful plain on the top, having a pleaſant proſpect all round it, and a good landmark for the uſe of mariners. The liſt of parliament-men for this borough, formerly divided into two parts, by the names of Sutton-Valtort and Sutton-Prior, commences the 26th of Edward I. and continues to the 14th of Edward III. after which we find no return made for it till the 20th of Henry VI. when the privilege was renewed. On the Haw is a fort, which at once awes the town and defends the harbour. Here is a ferry over the Tamar, called Crumwell or Crimble Paſſage, the weſt ſide of which is called Weſtone-Houſe, and is in Devonſhire, though moſt of the pariſh wherein it ſtands is in Cornwall. In April 1759 the parliament granted 25,159 l. for the better fortifying the town and dock of Plymouth; which was viſited by George III. with the Queen, &c. in Auguſt 1789. N. Lat. 50. 26. W. Long. 4. 15.

PLYMOUTH, in New England, a ſea-port town, and capital of the county of the ſame name, in the province of Maſſachuſets Bay, in North America. It is remarkable for having been the firſt ſettlement in New England, and for having had the firſt place of worſhip. It is ſeated at the ſouth end of Plymouth Bay. W. Long. 70. 10. N. Lat. 41. 58.

Plynteria. PLYNTERIA, a Grecian feſtival in honour of Aglauros, or rather of Minerva, who received from the daughter of Cecrops the name of Aglauros. The word is derived from πλυνειν, *lavare*, becauſe during the ſolemnity they undreſſed the ſtatue of the goddeſs and waſhed it. The day on which it was obſerved was looked upon as unfortunate and inauſpicious; and therefore no perſon was permitted to appear in the temples, as they were purpoſely ſurrounded with ropes. The arrival of Alcibiades in Athens that day was thought very unfortunate, but the ſucceſs that ever after attended him proved it to be otherwiſe. It was cuſtomary at this feſtival to bear in proceſſion a cluſter of figs; which intimated the progreſs of civilization among the firſt inhabitants of the earth, as figs ſerved them for food after they had found a diſlike for acorns.

PNEUMATICS.

[1] efinition the term. THIS term is restricted, in the present habits of our language, to that part of natural philosophy which treats of the mechanical properties of elastic fluids. The word, in its original meaning, expresses a quality of air, or more properly of breath. Under the article PHYSICS we observed, that in a great number of languages the term used to express breath was also one of the terms used to express the animating principle, nay, the intellectual substance, the soul. It has been perhaps owing to some attention to this chance of confusion that our philosophers have appropriated the term PNEUMATICS to the science of the mechanical properties of air, and PNEUMATOLOGY to the science of the intellectual phenomena consequent on the operations or affections of our thinking principle.

2 tent of e science We have extended (on the authority of present custom) the term PNEUMATICS to the study of the mechanical properties of all elastic or sensibly compressible fluids, that is, of fluids whose elasticity and compressibility become an interesting object of our attention; as the term HYDROSTATICS is applied to the study of the mechanical properties of such bodies as interest us by their fluidity or liquidity only, or whose elasticity and compressibility are not familiar or interesting, though not less real or general than in the case of air and all vapours.

3 precise it to the ferent sses of dies. We may be indulged in the observation by the bye, that there is no precise limit to the different classes of natural bodies with respect to their mechanical properties. There is no such thing as a body perfectly hard, perfectly soft, perfectly elastic, or perfectly incompressible. All bodies have some degree of elasticity intermixed with some degree of ductility. Water, mercury, oil, are compressible; but their compressibility need not be attended to in order perfectly to understand the phenomena consequent on their materiality, fluidity, and gravity. But if we neglect the compressibility of air, we remain ignorant of the cause and nature of its most interesting phenomena, and but imperfectly informed with respect to those in which its elasticity has no share; and it is convenient to attend to this distinction in our researches, in order to understand those phenomena which depend solely or chiefly on compressibility and elasticity. This observation is important; for here elasticity appears in its most simple form, unaccompanied with any other mechanical affection of matter (if we except gravity), and lies most open to our observation, whether employed for investigating the nature of this very property of bodies, or for explaining its mode of action. We shall even find that the constitution of an avowedly elastic fluid, whose compressibility is so very sensible, will give us the distinctest notions of fluidity in general, and enable us to understand its *characteristic appearances*, by which it is distinguished from solidity, namely, the *equable* distribution of pressure thro' all its parts in every direction, and the horizontality which its surface assumes by the action of gravity: phenomena which have been assumed as equivalent to the definition of a perfect fluid, and from which all the laws of hydrostatics and hydraulics have been derived. And these laws have been applied to the explanation of the phenomena around us; and water, mercury, oil, &c. have been denominated fluid only because their appearances have been found to tally exactly with these consequences of this definition, while the definition itself remains in the form of an assumption, unsupported by any other proof of its obtaining in nature. A real mechanical philosopher will therefore attach himself with great eagerness to this property, and consider it as an introduction to much natural science.

Of all the sensibly compressible fluids air is the most familiar, was the first studied, and the most minutely examined. It has therefore been generally taken as the example of their mechanical properties, while those mechanical properties which are peculiar to any of them, and therefore characteristic, have usually been treated as an appendix to the general science of pneumatics. No objection occurs to us against this method, which will therefore be adopted in treating this article. 4 Air the most familiar compressible fluid.

But although the mechanical properties are the proper subjects of our consideration, it will be impossible to avoid considering occasionally properties which are more of a chemical nature; because they occasion such modifications of the mechanical properties as would frequently be unintelligible without considering them in conjunction with the other; and, on the other hand, the mechanical properties produce such modifications of the properties merely chemical, and of very interesting phenomena consequent on them, that these would often pass unexplained unless we give an account of them in this place. 5 Different properties of it.

By *mechanical properties* we would be understood to mean such as produce, or are connected with, sensible changes of motion, and which indicate the presence and agency of moving or mechanical powers. They are therefore the subject of mathematical discussion; admitting of measure, number, and direction, notions purely mathematical. 6 Mechanical properties.

We shall therefore begin with the consideration of air.

It is by no means an idle question, "*What is this* air of which so much is said and written?" We see nothing, we feel nothing. We find ourselves at liberty to move about in any direction without any let or hinderance. Whence, then, the assertion, that we are surrounded with a *matter* called air? A few very simple observations and experiments will show us that this assertion is well founded. 7 What is air?

We are accustomed to say, that a vessel is empty when we have poured out of it the water which it contained. Take a cylindrical glass jar (fig. 1.), having a small hole in its bottom; and having stopped this hole, fill the jar with water, and then pour out the water, leaving the glass empty, in the common acceptation of the word. Now, throw a bit of cork, or any light body, on the surface of water in a cistern: cover this with the glass jar held in the hand with its bottom upwards, and move it downwards, keeping it all the while in an upright position. The cork will continue to float on the surface of the water in the inside of the glass, 8 Proofs that it is matter, Plate CCCXCIX.

and

and will most distinctly show whereabouts that surface is. It will thus be seen, that the water within the glass has its surface considerably lower than that of the surrounding water; and however deep we immerge the glass, we shall find that the water will never rise in the inside of it so as to fill it. If plunged to the depth of 32 feet, the water will only half fill it; and yet the acknowledged laws of hydrostatics tell us, that the water would fill the glass if there were nothing to hinder it. There is therefore something already within the glass which prevents the water from getting into it; manifesting in this manner the most distinctive property of matter, viz. the hindering other matter from occupying the same place at the same time.

9 Possessed of impulsive force,

While things are in this condition, pull the stopper out of the hole in the bottom of the jar, and the water will instantly rise in the inside of the jar, and stand at an equal height within and without. This is justly ascribed to the escape through the hole of the *matter* which formerly obstructed the entry of the water: for if the hand be held before the hole, a puff will be distinctly felt, or a feather held there will be blown aside; indicating in this manner that what prevented the entry of the water, and now escapes, possesses another characteristic property of matter, *impulsive force*. The materiality is concluded from this appearance in the same manner that the materiality of water is concluded from the impulse of a jet from a pipe. We also see the mobility of the formerly pent up, and now liberated, substance, in consequence of external pressure, viz. the pressure of the surrounding water.

10 Impenetrability,

Also, if we take a smooth cylindrical tube, shut at one end, and fit a plug or cork to its open end, so as to slide along it, but so tightly as to prevent all passage by its sides; and if the plug be well soaked in grease, we shall find that no force whatever can push it to the bottom of the tube. There is therefore *something* within the tube preventing by its impenetrability the entry of the plug, and therefore possessing this characteristic of matter.

11 Elasticity,

In like manner, if, after having opened a pair of common bellows, we shut up the nozzle and valve hole, and try to bring the boards together, we find it impossible. There is something included which prevents this, in the same manner as if the bellows were filled with wool; but on opening the nozzle we can easily shut them, viz. by expelling this something; and if the compression is forcible, the something will issue with considerable force, and very sensibly impel any thing in its way.

12 Inertia, and mobility.

It is not accurate to say, that we move about without *any* obstruction; for we find, that if we endeavour to move a large fan with rapidity, a very sensible hinderance is perceived, and that a very sensible force must be exerted; and a sensible wind is produced, which will agitate the neighbouring bodies. It is therefore justly concluded that the motion is possible only in consequence of having driven this obstructing substance out of the way; and that this impenetrable, resisting, moveable, impelling substance, is *matter*. We perceive the perseverance of this matter in its state of rest when we wave a fan, in the same manner that we perceive the *inertia* of water when we move a paddle through it. The effects of wind in impelling our ships and mills, in tearing up trees, and overturning buildings, are equal indications of its perseverance in a state of motion.

To this matter, when at rest, we give the name Air; and when it is in motion we call it Wind.

13 It is therefore a material fluid,

Air, therefore, is a material fluid: a fluid, because its parts are easily moved, and yield to the smallest inequality of pressure.

14 Heavy, and

Air possesses some others of the very general, though not essential, properties of matter. It is heavy. This appears from the following facts.

1. It always accompanies this globe in its orbit round the sun, surrounding it to a certain distance, under the name of the Atmosphere, which indicates the being connected with the earth by its general force of gravity. It is chiefly in consequence of this that it is continually moving round the earth from east to west; forming what is called the trade-wind, to be more particularly considered afterwards. All that is to be observed on this subject at present is, that, in consequence of the disturbing force of the sun and moon, there is an accumulation of the air of the atmosphere, in the same manner as of the waters of the ocean, in those parts of the globe which have the moon near their zenith or nadir: and as this happens successively, going from the east to the west (by the rotation of the earth round its axis in the opposite direction), the accumulated air must gradually flow along to form the elevation. This is chiefly to be observed in the torrid zone; and the generality and regularity of this motion are greatly disturbed by the changes which are continually taking place in different parts of the atmosphere from causes which are not mechanical.

15 Supports the clouds,

2. It is in like manner owing to the gravity of the air that it supports the clouds and vapours which we see constantly floating in it. We have even seen bodies of no inconsiderable weight float, and even rise, in the air. Soap bubbles, and balloons filled with inflammable gas, rise and float in the same manner as a cork rises in water. This phenomenon proves the weight of the air in the same manner that the swimming of a piece of wood indicates the weight of the water which supports it.

16 Familiar proofs of its weight.

3. But we are not left to these refined observations for the proof of the air's gravity. We may observe familiar phenomena, which would be immediate consequences of the supposition that air is a heavy fluid, and, like other heavy fluids, presses on the outsides of all bodies immersed in or surrounded by it. Thus, for instance, if we shut the nozzle and valve hole of a pair of bellows after having squeezed the air out of them, we shall find that a very great force, even some hundred pounds, is necessary for separating the boards. They are kept together by the pressure of the heavy air which surrounds them in the same manner as if they were immersed in water. In like manner, if we stop the end of a syringe after its piston has been pressed down to the bottom, and then attempt to draw up the piston, we shall find a considerable force necessary, viz. about 15 or 16 pounds for every square inch of the section of the syringe. Exerting this force, we can draw up the piston to the top, and we can hold it there; but the moment we cease acting, the piston rushes down and strikes the bottom. It is called a suction, as we feel something as it were drawing in the piston; but it is really the weight of

of the incumbent air pressing it in. And this obtains in every position of the syringe; because the air is a fluid, and presses in every direction. Nay, it presses on the syringe as well as on the piston; and if the piston be hung by its ring on a nail, the syringe requires force to draw it down (just as much as to draw the piston up); and if it be let go, it will spring up, unless loaded with at least 15 pounds for every square inch of its transverse section (see fig. 2.)

Plate CCXCIX.

17 Air may even be weighed.

4. But the most direct proof of the weight of the air is had by weighing a vessel empty of air, and then weighing it again when the air has been admitted; and this, as it is the most obvious consequence of its weight, has been asserted as long ago as the days of Aristotle. He says (περὶ οὐρανοῦ, iv. 4.), That all bodies are heavy in their place except fire: even air is heavy; for a blown bladder is heavier than when it is empty. It is somewhat surprising that his followers should have gone into the opposite opinion, while professing to maintain the doctrine of their leader. If we take a very large and limber bladder, and squeeze out the air very carefully, and weigh it, and then fill it till the wrinkles just begin to disappear, and weigh it again, we shall find no difference in the weight. But this is not Aristotle's meaning; because the bladder, considered as a vessel, is equally full in both cases, its dimensions being changed. We cannot take the air out of a bladder without its immediately collapsing. But what would be true of a bladder would be equally true of any vessel. Therefore, take a round vessel A (fig. 5.), fitted with a stopcock B, and syringe C. Fill the whole with water, and press the piston to the bottom of the syringe. Then keeping the cock open, and holding the vessel upright, with the syringe undermost, draw down the piston. The water will follow it by its weight, and leave part of the vessel empty. Now shut the cock, and again push up the piston to the bottom of the syringe; the water escapes through the piston valve, as will be explained afterward: then opening the cock, and again drawing down the piston, more water will come out of the vessel. Repeat this operation till all the water have come out. Shut the cock, unscrew the syringe, and weigh the vessel very accurately. Now open the cock, and admit the air, and weigh the vessel again, it will be found heavier than before, and this additional weight is the weight of the air which fills it; and it will be found to be 523 grains, about an ounce and a fifth avoirdupoise, for every cubic foot that the vessel contains. Now since a cubic foot of water would weigh 1000 ounces, this experiment would show that water is about 840 times heavier than air. The most accurate judgment of this kind of which we have met with an account is that recorded by Sir George Shuckbourgh, which is in the 67th vol. of the Philosophical Transactions, p. 560. From this it follows, that when the air is of the temperature 53, and the barometer stands at $29\frac{3}{4}$ inches, the air is 836 times lighter than water. But the experiment is not susceptible of sufficient accuracy for determining the exact weight of a cubic foot of air. Its weight is very small; and the vessel must be strong and heavy, so as to overload any balance that is sufficiently nice for the experiment.

18 The most convenient method of doing this.

To avoid this inconvenience, the whole may be weighed in water, first loading the vessel so as to make it preponderate an ounce or two in the water. By this means the balance will be loaded only with this small preponderancy. But even in this case there are considerable sources of error, arising from changes in the specific gravity of the water and other causes. The experiment has often been repeated with this view, and the air has been found at a medium to be about 840 times as light as water, but with great variations, as may be expected from its very heterogeneous nature, in consequence of its being the menstruum of almost every fluid, of all vapours, and even of most solid bodies; all which it holds in solution, forming a fluid perfectly transparent, and of very different density according to its composition. It is found, for instance, that perfectly pure air of the temperature of our ordinary summer is considerably denser than when it has dissolved about half as much water as it can hold in that temperature; and that with this quantity of water the difference of density increases in proportion as the mass grows warmer, for damp air is more expansible by heat than dry air. We shall have occasion to consider this subject again, when we treat of the connection of the mechanical properties of air with the state of the weather. See Weather.

Such is the result of the experiment suggested by Aristotle, evidently proving the weight of the air; and yet, as has been observed, the Peripatetics, who profess to follow the *dictates* of Aristotle, uniformly refused it this property. It was a matter long debated among the philosophers of the last century. The reason was, that Aristotle, with that indistinctness and inconsistency which is observed in all his writings which relate to matters of fact and experience, assigns a different cause to many phenomena which any man led by common observation would ascribe to the weight of the air. Of this kind is the rise of water in pumps and syphons, which all the Peripatetics had for ages ascribed to something which they called *nature's abhorrence of a void*. Aristotle had asserted (for reasons not our business to adduce at present), that all nature was full of being, and that nature abhorred a void. He adduces many facts, in which it appears, that if not absolutely impossible, it is very difficult, and requires great force, to produce a space void of matter. When the operation of pumps and syphons came to be known, the philosophers of Europe (who had all embraced the Peripatetic doctrines) found in this fancied horror of a fancied mind (what else is this that nature abhors?) a ready solution of the phenomena. We shall state the facts, that every reader may see what kinds of reasoning were received among the learned not two centuries ago.

19 This property of air denied by the Peripatetics, though acknowledged by their master.

20 Construction of pumps in the last century.

Pumps were then constructed in the following manner: A long pipe GB (fig. 4.) was set in the water of the well A. This was fitted with a sucker or piston C, having a long rod CF, and was furnished with a valve B at the bottom, and a lateral pipe DE at the place of delivery, also furnished with a valve. The fact is, that if the piston be thrust down to the bottom, and then drawn up, the water will follow it; and upon the piston being again pushed down, the water shuts the valve B by its weight, and escapes or is expelled at the valve E; and on drawing up the piston again the valve E is shut, the water again rises after the piston, and is again expelled at its next descent.

The Peripatetics explain all this by saying, that if the water did *not follow the piston* there would be a void between

21 Their operation accounted for by the Peripatetics.

between them. But nature abhors a void; or a void is impoffible: therefore the water follows the pifton.—It is not worth while to criticife the wretched reafoning in this pretence to explanation. It is all overturned by one obfervation. Suppofe the pipe fhut at the bottom, the pifton *can* be drawn up, and thus a void produced. No, fay the Peripatetics; and they fpeak of certain fpirits, effluvia, &c. which occupy the place. But if fo, why needs the water rife? This therefore is not the caufe of its afcent. It is a curious and important phenomenon.

22 Galileo firft accounted for it rationally

The fagacious Galileo feems to have been the firft who ferioufly afcribed this to the weight of the air. Many before him had fuppofed air heavy; and thus explained the difficulty of raifing the board of bellows, or the pifton of a fyringe, &c. But he diftinctly applies to this allowed weight of the air all the confequences of hydroftatical laws; and he reafons as follows.

23 By the weight of the atmofphere,

The heavy air refts on the water in the ciftern, and preffes it with its weight. It does the fame with the water in the pipe, and therefore both are on a level: but if the pifton, after being in contact with the furface of the water, be drawn up, there is no longer any preffure on the furface of the water within the pipe; for the air now refts on the pifton only, and thus occafions a difficulty in drawing it up. The water in the pipe, therefore, is in the fame fituation as if more water were poured into the ciftern, that is, as much as would exert the fame preffure on its furface as the air does. In this cafe we are certain that the water will be preffed into the pipe, and will raife up the water already in it, and follow it till it is equally high within and without. The fame preffure of the air fhuts the valve E during the defcent of the pifton. (See *Gal. Difcourfes.*)

24 And predicted the height to which water would rife in them.

He did not wait for the very obvious objection, that if the rife of the water was the effect of the air's preffure, it would alfo be its meafure, and would be raifed and fupported only to a certain height. He directly faid fo, and adduced this as a decifive experiment. If the horror of a void be the caufe, fays he, the water muft rife to any height however great; but if it be owing to the preffure of the air, it will only rife till the weight of the water in the pipe is in equilibrio with the preffure of the air, according to the common laws of hydroftatics. And he adds, that this is well known; for it is a fact, that pumps will not *draw* water much above forty palms, although they may be made to *propel* it, or to *lift it* to any height. He then makes an affertion, which, if true, will be decifive. Let a very long pipe, fhut at one end, be filled with water, and let it be erected perpendicularly with the clofe end uppermoft, and a ftopper in the other end, and then its lower orifice immerfed into a veffel of water; the water will fubfide in the pipe upon removing the ftopper, till the remaining column is in equilibrio with the preffure of the external air. This experiment he propofes to the curious; faying, however, that he thought it unneceffary, there being already fuch abundant proofs of the air's preffure.

25 His prediction verified by Toricelli's experiment

It is probable that the cumberfomenefs of the neceffary apparatus protracted the making of this experiment. Another equally conclufive, and much eafier, was made in 1642 after Galileo's death, by his zealous and learned difciple Toricelli. He filled a glafs tube, clofe at one end, with mercury; judging, that if the fupport of the water was owing to the preffure of the air, and was the meafure of this preffure, mercury would in like manner be fupported by it, and this at a height which was alfo the meafure of the air's preffure, and therefore 13 times lefs than water. He had the pleafure of feeing his expectation verified in the completeft manner; the mercury defcending in the tube AB (fig. 5.), and finally fettling at the height *f*B of $29\frac{1}{2}$ Roman inches: and he found, that when the tube was inclined, the point *f* was in the fame horizontal plane with *f* in the upright tube, according to the received laws of hydroftatical preffure. The experiment was often repeated, and foon became famous, exciting great controverfies among the philofophers about the poffibility of a vacuum. About three years afterwards the fame experiment was publifhed, at Warfaw in Poland, by Valerianus Magnus as his own fuggeftion and difcovery: but it appears plain from the letters of Roberval, not only that Toricelli was prior, and that his experiment was the general topic of difcuffion among the curious; but alfo highly probable that Valerianus Magnus was informed of it when at Rome, and daily converfant with thofe who had feen it. He denies, however, even having heard of the name of Toricelli.

Plate CCCXCI.

This was the era of philofophical ardour; and we think that it was Galileo's invention and immediate application of the telefcope which gave it vigour. Difcoveries of the moft wonderful kind in the heavens, and which required no extent of previous knowledge to underftand them, were thus put into the hands of every perfon who could purchafe a fpy-glafs; while the high degree of credibility which fome of the difcoveries, fuch as the phafes of Venus and the rotation and fatellites of Jupiter, gave to the Copernican fyftem, immediately fet the whole body of the learned in motion. Galileo joined to his ardour a great extent of learning, particularly of mathematical knowledge and found logic, and was even the firft who formally united mathematics with phyfics; and his treatife on accelerated motion was the firft, and a precious fruit of this union. About the years 1642 and 1644, we find clubs of gentlemen affociated in Oxford and London for the cultivation of knowledge by experiment; and before 1655 all the doctrines of hydroftatics and pneumatics were familiar there, eftablifhed upon experiment. Mr Boyle procured a coalition and correfpondence of thefe clubs under the name of the Invifible and Philofophical Society. In May 1658 Mr Hooke finifhed for Mr Boyle an air-pump, which had employed him a long time, and occafioned him feveral journeys to London for things which the workmen of Oxford could not execute. He fpeaks of this as a great improvement on Mr Boyle's own pump, which he had been ufing fome time before. Boyle therefore muft have invented his air-pump, and was not indebted for it to Schottus's account of Otto Guerick's, publifhed in his (Schottus) *Mechanica Hydraulo-pneumatica* in 1657, as he afferts *(Techna Curiofa)*. The Royal Society of London arofe in 1656 from the coalition of thefe clubs, after 15 years co-operation and correfpondence. The Montmorine Society at Paris had fubfifted nearly about the fame time; for we find Pafchal in 1648 fpeaking of the meetings in the Sorbonne College, from which we know that fociety originated.—Nuremberg, in Germany, was alfo a diftinguifhed feminary of experimental philofophy. The magiftrates,

26 Origin of the Royal Society, &c.

27 Invention of the air-pump.

magiſtrates, ſenſible of its valuable influence in manufactures, the ſource of the opulence and proſperity of their city, and many of them philoſophers, gave philoſophy a profeſſed and munificent patronage, furniſhing the philoſophers with a copious apparatus, a place of aſſembly, and a fund for the expence of their experiments; ſo that this was the firſt academy of ſciences out of Italy under the patronage of government. In Italy, indeed, there had long exiſted inſtitutions of this kind. Rome was the centre of church-government, and the reſort of all expectants for preferment. The clergy were the majority of the learned in all Chriſtian nations, and particularly of the ſyſtematic philoſophers. Each, eager to recommend himſelf to notice, brought forward every thing that was curious; and they were the willing vehicles of philoſophical communication. Thus the experiments of Galileo and Toricelli were rapidly diffuſed by perſons of rank, the dignitaries of the church, or by the monks their obſequious ſervants. Perhaps the recent defection of England, and the want of a reſiding embaſſy at Rome, made her ſometimes late in receiving or ſpreading philoſophical reſearches, and was the cauſe that more was done there *proprio Marte*.

28 Expe-[r]iments of [Gali]leo and [Tori]celli [rapid]ly dif-[fused].

We hope to be excuſed for this digreſſion. We were naturally led into it by the pretenſions of Valerianus Magnus to originality in the experiment of the mercury ſupported by the preſſure of the air. Such is the ſtrength of national attachment, that there were not wanting ſome who found that Toricelli had borrowed his experiment from Honoratus Fabri, who had propoſed and explained it in 1641; but whoever knows the writings of Toricelli, and Galileo's high opinion of him, will never think that he could need ſuch helps. (See this ſurmiſe of Mounier in *Schott. Tech. Cur.* III. at the end.

29 [The] merit [of T]oricel-[li c]laimed [by o]thers

Galileo muſt be conſidered as the author of the experiment when he propoſes it to be made. Valerianus Magnus owns himſelf indebted to him for the principle and the contrivance of the experiment. It is neither wonderful that many ingenious men, of one opinion, and inſtructed by Galileo, ſhould ſeparately hit on ſo obvious a thing; nor that Toricelli, his immediate diſciple, his enthuſiaſtic admirer, and who was in the habits of correſponding with him till his death in 1642, ſhould be the firſt to put it in practice. It became the ſubject of diſpute from the national arrogance and ſelf-conceit of ſome Frenchmen, who have always ſhown themſelves diſpoſed to conſider their nation as at the head of the republic of letters, and cannot brook the concurrence of any foreigners. Roberval was in this inſtance, however, the champion of Toricelli; but thoſe who know his controverſies with the mathematicians of France at this time will eaſily account for this exception.

30 [J]uſtly.

All now agree in giving Toricelli the honour of the *firſt* invention; and it univerſally paſſes by the name of the Toricellian Experiment. The tube is called the Toricellian Tube; and the ſpace left by the mercury is called the Toricellian Vacuum, to diſtinguiſh it from the Boylean Vacuum, which is only an extreme rarefaction.

31 [Thi]s re-[peate]d in [vario]us [form]s.

The experiment was repeated in various forms, and with apparatus which enabled philoſophers to examine ſeveral effects which the vacuum produced on bodies expoſed in it. This was done by making the upper part of the tube terminate in a veſſel of ſome capacity, or communicate with ſuch a veſſel, in which were included along with the mercury bodies on which the experiments were to be made. When the mercury had run out, the phenomena of theſe bodies were carefully obſerved.

32 An objection to the concluſion drawn from it obviated.

An objection was made to the concluſion drawn from Toricelli's experiment, which appears formidable. If the Toricellian tube be ſuſpended on the arm of a balance, it is found that the counterpoiſe muſt be equal to the weight both of the tube and of the mercury it contains. This could not be, ſay the objectors, if the mercury were ſupported by the air. It is evidently ſupported by the balance; and this gave riſe to another notion of the cauſe different from the peripatetic *fuga vacui*: a ſuſpenſive force, or rather attraction, was aſſigned to the upper part of the tube.

But the true explanation of the phenomenon is moſt eaſy and ſatisfactory. Suppoſe the mercury in the ciſtern and tube to freeze, but without adhering to the tube, ſo that the tube could be freely drawn up and down. In this caſe the mercury is ſupported by the baſe, without any dependence on the preſſure of the air; and the tube is in the ſame condition as before, and the ſolid mercury performs the office of a piſton to this kind of ſyringe. Suppoſe the tube thruſt down till the top of it touches the top of the mercury. It is evident that it muſt be drawn up in oppoſition to the preſſure of the external air, and it is preciſely ſimilar to the ſyringe mentioned in n° 16. The weight ſuſtained therefore by this arm of the balance is the weight of the tube and the downward preſſure of the atmoſphere on its top.

33 Galileo's original experiment performed.

The curioſity of philoſophers being thus excited by this very manageable experiment, it was natural now to try the original experiment propoſed by Galileo. Accordingly Berti in Italy, Paſchal in France, and many others in different places, made the experiment with a tube filled with water, wine, oil, &c. and all with the ſucceſs which might be expected in ſo ſimple a matter: and the doctrine of the weight and preſſure of the air was eſtabliſhed beyond contradiction or doubt. All was done before the year 1648.—A very beautiful experiment was exhibited by Auzout, which completely ſatiſfied all who had any remaining doubts.

34 An experiment by Auzout Plate CCCXCIX.

A ſmall box or phial EFGH (fig. 6.) had two glaſs tubes, AB, CD, three feet long, inſerted into it in ſuch a manner as to be firmly fixed in one end, and to reach nearly to the other end. AB was open at both ends, and CD was cloſe at D. This apparatus was completely filled with mercury, by unſcrewing the tube AB, filling the box, and the hole CD; then ſcrewing in the tube AB, and filling it: then holding a finger on the orifice A, the whole was inverted and ſet upright in the poſition repreſented in figure 7, immerſing the orifice A (now *a*) in a ſmall veſſel of quickſilver. The reſult was, that the mercury ran out at the orifice *a*, till its ſurface *m n* within the phial deſcended to the top of the tube *b a*. The mercury alſo began to deſcend in the tube *d c* (formerly DC) and run over into the tube *b a*, and ran out at *a*, till the mercury in *d c* was very near equal in a level with *m n*. The mercury deſcending in *b a* till it ſtood at *k*, 29½ inches above the ſurface *o p* of the mercury in the ciſtern, juſt as in the Toricellian tube.

The rationale of this experiment is very eafy. The whole apparatus may firft be confidered as a Toricellian tube of an uncommon fhape, and the mercury would flow out at *a*. But as foon as a drop of mercury comes out, leaving a fpace above *m n*, there is nothing to keep up the mercury in the tube *d c*. Its mercury therefore defcends alfo; and running over into *b a*, continues to fupply its expence till the tube *d c* is almoft empty, or can no longer fupply the wafte of *b a*. The inner furface therefore falls as low as it can, till it is level with *b*. No more mercury can enter *b a*, yet its column is too heavy to be fupported by the preffure of the air on the mercury in the ciftern below; it therefore defcends in *b a*, and finally fettles at the height *k a*, equal to that of the mercury in the Toricellian tube.

35
Decifive of the queftion.

The pretty circumftance of the experiment remains. Make a fmall hole *g* in the upper cap of the box. The external air immediately rufhes in by its weight, and now preffes on the mercury in the box. This immediately raifes the mercury in the tube *d c* to *l*, $29\frac{1}{2}$ inches above *m n*. It preffes on the mercury at *k* in the tube *b a*, balancing the preffure of the air in the ciftern. The mercury in the tube therefore is left to the influence of its own weight, and it defcends to the bottom. Nothing can be more appofite or decifive.

36
The gravity of the air therefore a ftatical principle from which we obtain

And thus the doctrine of the gravity and preffure of the air is eftablifhed by the moft unexceptionable evidence: and we are intitled to affume it as a ftatical principle, and to affirm *à priori* all its legitimate confequences.

And in the firft place, we obtain an exact meafure of the preffure of the atmofphere. It is precifely equal to the weight of the column of mercury, of water, of oil, &c. which it can fupport; and the Toricellian tube, or others fitted up upon the fame principle, are juftly termed *barofcopes* and *barometers* with refpect to the air. Now it is obferved that water is fupported at the height of

37
An exact meafure of the preffure of the atmofphere

32 feet nearly: The weight of the column is exactly 2000 avoirdupois pounds on every fquare foot of bafe; or $13\frac{9}{10}$ on every fquare inch. The fame conclufion very nearly may be drawn from the column of mercury, which is nearly $29\frac{1}{2}$ inches high when in equilibrium with the preffure of the air. We may here obferve, that the meafure taken from the height of a column of water, wine, fpirits, and the other fluids of confiderable volatility, as chemifts term it, is not fo exact as that taken from mercury, oil, and the like. For it is obferved, that the volatile fluids are converted by the ordinary heat of our climates into vapour when the confining preffure of the air is removed; and this vapour, by its elafticity, exerts a fmall preffure on the furface of the water, &c. in the pipe, and thus counteracts a fmall part of the external preffure; and therefore the column fupported by the remaining preffure muft be lighter, that is, fhorter. Thus it is found, that rectified fpirits will not ftand much higher than is competent to a weight of 13 pounds on an inch, the elafticity of its vapour balancing about $\frac{1}{14}$ of the preffure of the air. We fhall afterwards have occafion to confider this matter more particularly.

As the medium height of the mercury in the barometer is $29\frac{1}{2}$ inches, we fee that the whole globe fuftains a preffure equal to the whole weight of a body of mercury of this height; and that all bodies on its furface fuftain a part of this in proportion to their furfaces. An ordinary fized man fuftains a preffure of feveral thoufand pounds. How comes it then that we are not fenfible of a preffure which one fhould think enough to crufh us together? This has been confidered as a ftrong objection to the preffure of the air; for when a man is plunged a few feet under water, he is very fenfible of the preffure. The anfwer is by no means fo eafy as is commonly imagined. We feel very diftinctly the effects of removing this preffure from any part of the body. If any one will apply the open end of a fyringe to his hand, and then draw up the pifton, he will find his hand fucked into the fyringe with great force, and it will give pain; and the foft part of the hand will fwell into it, being preffed in by the neighbouring parts, which are fubject to the action of the external air. If one lays his hand on the top of a long perpendicular pipe, fuch as a pump filled to the brim with water, which is at firft prevented from running out by the valve below; and if the valve be then opened, fo that the water defcends, he will then find his hand fo hard preffed to the top of the pipe that he cannot draw it away. But why do we only feel the *inequality* of preffure? There is a fimilar inftance wherein we do not feel it, although we cannot doubt of its exiftence. When a man goes flowly to a great depth under water in a diving-bell, we know unqueftionably that he is expofed to a new and very great preffure, yet he does not feel it. But thofe facts are not fufficiently familiar for general argument. The human body is a bundle of folids, hard or foft, filled or mixed with fluids, and there are few or no parts of it which are empty. All communicate either by veffels or pores; and the whole furface is a fieve through which the infenfible perfpiration is performed. The whole extended furface of the lungs is open to the preffure of the atmofphere; every thing is therefore in equilibrio: and if free or fpeedy accefs be given to every part, the body will not be damaged by the preffure, however great, any more than a wet fponge would be deranged by plunging it any depth in water. The preffure is inftantaneoufly diffufed by means of the incompreffible fluids with which the parts are filled; and if any parts are filled with air or other compreffible fluids, thefe are compreffed till their elafticity again balances the preffure. Befides, all our fluids are acquired flowly, and gradually mixed with that proportion of air which they can diffolve or contain. The whole animal has grown up in this manner from the firft vital atom of the embryo. For fuch reafons the preffure can occafion no change of fhape by fqueezing together the flexible parts; nor any obftruction by compreffing the veffels or pores. We cannot fay what would be felt by a man, were it poffible that he could have been produced and grown up *in vacuo*, and then fubjected to the compreffion. We even know that any fudden and confiderable change of general preffure is very feverely felt. Perfons in a diving-bell have been almoft killed by letting them down or drawing them up too fuddenly. In drawing up, the elaftic matters within have fuddenly fwelled, and not finding an immediate efcape have burft the veffels. Dr Halley experienced this, the blood gufhing out from his ears by the expanfion of air contained in the internal cavities of this organ, from which there are but very flender paffages.

38
A difficulty folved.

39 e wea- r-glass.

A very important obfervation recurs here: the preffure of the atmofphere is variable. This was obferved almoft as foon as philofophers began to attend to the barometer. Pafchal obferved it in France, and Defcartes obferved it in Sweden in 1650. Mr Boyle and others obferved it in England in 1656. And before this, obfervers, who took notice of the concomitancy of thefe changes of aerial preffure with the ftate of the atmofphere, remarked, that it was generally greateft in winter and in the night; and certainly moft variable during winter and in the northern regions. Familiar now with the weight of the air, and confidering it as the vehicle of the clouds and vapours, they noted with care the connection between the weather and the preffure of the air, and found that a great preffure of the air was generally accompanied with fair weather, and a diminution of it with rain and mifts. Hence the barometer came to be confidered as an index not only of the prefent ftate of the air's weight, but alfo as indicating by its variations changes of weather. It became a WEATHER-GLASS, and continued to be anxioufly obferved with this view. This is an important fubject, and will afterwards be treated in fome detail.

40 e pref- of the in pro- tion to eleva-

In the next place, we may conclude that the preffure of the air will be different in different places, according to their elevation above the furface of the ocean: for if air be an heavy fluid, it muft prefs in fome proportion according to its perpendicular height. If it be a homogeneous fluid of equal denfity and weight in all its parts, the mercury in the ciftern of a barometer muft be preffed precifely in proportion to the depth to which that ciftern is immerfed in it; and as this preffure is exactly meafured by the height of the mercury in the tube, the height of the mercury in the Toricellian tube muft be exactly proportional to the depth of the place of obfervation under the furface of the atmofphere.

41 t fup- d by cartes Pafchal proved xperi- ts,

The celebrated Defcartes firft entertained this thought (Epift. 67. of Pr. III.), and foon after him Pafchal. His occupation in Paris not permitting him to try the juftnefs of his conjecture, he requefted Mr Perrier, a gentleman of Clermont in Auvergne, to make the experiment, by obferving the height of the mercury at one and the fame time at Clermont and on the top of a very high mountain in the neighbourhood. His letters to Mr Perrier in 1647 are ftill extant. Accordingly Mr Perrier, in September 1648, filled two equal tubes with mercury, and obferved the heights of both to be the fame, viz. $26\frac{7}{24}$ inches, in the garden of the convent of the Friars Minims, fituated in the loweft part of Clermont. Leaving one of them there, and one of the fathers to obferve it, he took the other to the top of Puy de Domme, which was elevated nearly 500 French fathoms above the garden. He found its height to be $23\frac{2}{24}$ inches. On his return to the town, in a place called *Font de l'Arbre*, 150 fathoms above the garden, he found it 25 inches; when he returned to the garden it was again $26\frac{7}{24}$, and the perfon fet to watch the tube which had been left faid that it had not varied the whole day. Thus a difference of elevation of 3000 French feet had occafioned a depreffion of $3\frac{1}{8}$ inches; from which it may be concluded, that $3\frac{1}{8}$ inches of mercury weighs as much as 3000 feet of air, and one-tenth of an inch of mercury as much as 96 feet of air. The next day he found, that taking the tube to the top of a fteeple 120 feet high made a fall of one-fixth of an inch. This gives 72 feet of air for one-tenth of an inch of mercury; but ill agreeing with the former experiment. But it is to be obferved, that a very fmall error of obfervation of the barometer would correfpond to a great difference of elevation, and alfo that the height of the mountain had not been meafured with any precifion. This has been fince done (Mem. Acad. par. 1703), and found to be 529 French toifes.

42 Which were repeated by others.

Pafchal publifhed an account of this great experiment (*Grande Exp. fur la Pefanteur de l'Air*), and it was quickly repeated in many places of the world. In 1653 it was repeated in England by Dr Power (Power's Exper. Phil.); and in Scotland, in 1661, by Mr Sinclair profeffor of philofophy in the univerfity of Glafgow, who obferved the barometer at Lanark, on the top of mount Tintock in Clydfdale, and on the top of Arthur's Seat at Edinburgh. He found a depreffion of two inches between Glafgow and the top of Tintock, three quarters of an inch between the bottom and top of Arthur's Seat, and $\frac{5}{32}$ of an inch at the cathedral of Glafgow on a height of 126 feet. See Sinclair's *Ars Nova et Magna Gravitatis et Levitatis; Sturmii Collegium Experimentale*, and *Schotti Technica Curiofa*.

43 Hence a method of meafuring heights,

Hence we may derive a method of meafuring the heights of mountains. Having afcertained with great precifion the elevation correfponding to a fall of one-tenth of an inch of mercury, which is nearly 90 feet, we have only to obferve the length of the mercurial column at the top and bottom of the mountain, and to allow 90 feet for every tenth of an inch. Accordingly this method has been practifed with great fuccefs: but it requires an attention to many things not yet confidered; fuch as the change of denfity of the mercury by heat and cold; the changes of denfity of air, which are much more remarkable from the fame caufes; and above all, the changes of the denfity of air from its compreffibility; a change immediately connected with or dependent on the very elevation we wifh to meafure. Of all thefe afterwards.

44 Alfo a meafure of the denfity of the air,

Thefe obfervations give us the moft accurate meafure of the denfity of the air and its fpecific gravity. This is but vaguely though directly meafured by weighing air in a bladder or veffel. The weight of a manageable quantity is fo fmall, that a balance fufficiently ticklifh to indicate even very fenfible fractions of it is overloaded by the weight of the veffel which contains it, and ceafes to be exact: and when we take Bernoulli's ingenious method of fufpending it in water, we expofe ourfelves to great rifk of error by the variation of the water's denfity. Alfo it muft neceffarily be humid air which we can examine in this way: but the proportion of an elevation in the atmofphere to the depreffion of the column of mercury or other fluid, by which we meafure its preffure, gives us at once the proportion of this weight or their fpecific gravity. Thus fince it is found that in fuch a ftate of preffure that the barometer ftands at 30 inches, and the thermometer at 32°, 87 feet of rife produces one-tenth of an inch of fall in the barometer, the air and the mercury being both of the freezing temperature, we muft conclude that mercury is 10,440 times heavier or denfer than air. Then, by comparing mercury and water, we get $\frac{1}{801}$ nearly for the denfity of air relative to water: but this varies fo much by heat and moifture, that it is ufelefs to retain any thing more than a general notion of it; nor is it eafy to determine

whether

whether this method or that by actual weighing is preferable. It is extremely difficult to observe the height of the mercury in the barometer nearer than $\frac{1}{100}$ of an inch; and this will produce a difference of even five feet, or $\frac{1}{18}$ of the whole. Perhaps this is a greater proportion than the error in weighing.

45 And some knowledge of the height of the atmosphere.

From the same experiments we also derive some knowledge of the height of the aerial covering which surrounds our globe. When we raise our barometer 87 feet above the surface of the sea, the mercury falls about one-tenth of an inch in the barometer: therefore if the barometer shows 30 inches at the sea-shore, we may expect that, by raising it 300 times 87 feet or 5 miles, the mercury in the tube will descend to the level of the cistern, and that this is the height of our atmosphere. But other appearances lead us to suppose a much greater height. Meteors are seen with us much higher than this, and which yet give undoubted indication of being supported by our air. There can be little doubt, too, that the visibility of the expanse above us is owing to the reflection of the sun's light by our air. Were the heavenly spaces perfectly transparent, we should no more see them than the purest water through which we see other objects; and we see *them* as we see water tinged with milk or other fæculæ. Now it is easy to show, that the light which gives us what is called twilight must be reflected from the height of at least 50 miles; for we have it when the sun is depressed 18 degrees below our horizon.

46 Why this knowledge is not accurate.

A little attention to the constitution of our air will convince us, that the atmosphere must extend to a much greater height than 300 times 87 feet. We see from the most familiar facts that it is compressible; we can squeeze it in an ox-bladder. It is also heavy; pressing on the air in this bladder with a very great force, not less than 1500 pounds. We must therefore consider it as in a state of compression, existing in smaller room than it would assume if it were not compressed by the incumbent air. It must therefore be in a condition something resembling that of a quantity of fine carded wool thrown loosely into a deep pit; the lower strata carrying the weight of the upper strata, and being compressed by them; and so much the more compressed as they are further down, and only the upper stratum in its unconstrained and most expanded state. If we shall suppose this wool thrown in by a hundred weight at a time, it will be divided into strata of equal weights, but of unequal thickness; the lowest being the thinnest, and the superior strata gradually increasing in thickness. Now, suppose the pit filled with air, and reaching to the top of the atmosphere, the *weights* of all the strata above any horizontal plane in it is measured by the height of the mercury in the Toricellian tube placed in that plane; and one-tenth of an inch of mercury is just equal to the weight of the lowest stratum 87 feet thick: for on raising the tube 87 feet from the sea, the surface of the mercury will descend one-tenth of an inch. Raise the tube till the mercury fall another tenth: This stratum must be more than 87 feet thick; how much more we cannot tell, being ignorant of the law of the air's expansion. In order to make it fall a third tenth, we must raise it through a stratum still thicker; and so on continually.

All this is abundantly confirmed by the very first experiment made by the order and directions of Paschal: For by carrying the tube from the garden of the convent to a place 150 fathoms higher, the mercury fell $1\frac{7}{12}$ inches, or 1,2917; which gives about 69 feet 8 inches of aerial stratum for $\frac{1}{10}$ of an inch of mercury; and by carrying it from thence to a place 350 fathoms higher, the mercury fell $1\frac{11}{12}$, or 1,9167 inches, which gives 109 feet 7 inches for $\frac{1}{10}$ of an inch of mercury. These experiments were not accurately made; for at that time the philosophers, though zealous, were but *scholars* in the *science* of experimenting, and *novices* in the art. But the results abundantly show this general truth, and they are completely confirmed by thousands of subsequent observations. It is evident from the whole tenor of them, that the strata of air decrease in density as we ascend through the atmosphere; but it remained to be discovered what is the force of this decrease, that is, the law of the air's expansion. Till this be done we can say nothing about the constitution of our atmosphere: we cannot tell in what manner it is fittest for raising and supporting the exhalations and vapours which are continually arising from the inhabited regions; not as an excrementitious waste, but to be supported, perhaps manufactured, in that vast laboratory of nature, and to be returned to us in beneficent showers. We cannot use our knowledge for the curious, and frequently useful, purpose of measuring the heights of mountains and taking the levels of extensive regions; in short, without an accurate knowledge of this, we can hardly acquire any acquaintance with those mechanical properties which distinguish air from those liquids which circulate here below.

Having therefore considered at some length the leading consequences of the air's fluidity and gravity, let us consider its compressibility with the same care; and then, combining the agency of both, we shall answer all the purposes of philosophy, discover the laws, explain the phenomena of nature, and improve art. We proceed therefore to consider a little the phenomena which indicate and characterise this other property of the air. All fluids are elastic and compressible as well as air; but in them the compressibility makes no figure, or does not interest us while we are considering their pressures, motions, and impulsions. But in air the compressibility and expansion draw our chief attention, and make it a proper representative of this class of fluids.

47 Compre[ssi]bility of air

Nothing is more familiar than the compressibility of air. It is seen in a bladder filled with it, which we can forcibly squeeze into less room; it is seen in a syringe, of which we can push the plug farther and farther as we increase the pressure.

48 A famil[iar] phenom[e]non, wh[ich]

But these appearances bring into view another, and the most interesting, property of air, *viz.* its *elasticity*. When we have squeezed the air in the bladder or syringe into less room, we find that the force with which we *compressed* it is necessary to *keep it in this bulk*; and that if we cease to press it together, it will swell out and regain its natural dimensions. This distinguishes it essentially from such a body as a mass of flour, salt, or such like, which remain in the compressed state to which we reduce them.

49 Shews i[ts] elasticit[y]

There is therefore something which opposes the compression different from the simple impenetrability of the air: there is something that opposes mechanical force: there is something too which produces motion, not only resisting compression, but pushing back the compressing body, and communicating motion to it. As an

50 Resistin[g] force, a[nd] producin[g] motion

an arrow is gradually accelerated by the bow-ſtring preſſing it forward, and at the moment of its diſcharge is brought to a ſtate of rapid motion; ſo the ball from a pop-gun or wind-gun is gradually accelerated along the barrel by the preſſure of the air during its expanſion from its compreſſed ſtate, and finally quits it with an accumulated velocity. Theſe two motions are indications perfectly ſimilar of the elaſticity of the bow
51 and of the air.

...dity of air

Thus it appears that air is heavy and elaſtic. It needs little conſideration to convince us in a vague manner that it is fluid. The eaſe with which it is penetrated, and driven about in every direction, and the motion of it in pipes and channels, however crooked and intricate, intitle it to this character. But before we can proceed to deduce conſequences from its fluidity, and to offer them as a true account of what will happen in theſe circumſtances, it is neceſſary to exhibit ſome diſtinct and ſimple caſe, in which the characteriſtic mechanical property of a fluid is clearly and unequivocally obſerved in it. That property of fluids from which all the laws of hydroſtatics and hydraulics are derived with ſtricteſt evidence is, that any preſſure applied to any part of them is propagated through the whole maſs in every direction; and that in conſequence of this diffuſion of preſſure, any two external forces can be put in equilibrio by the interpoſition of a fluid, in the ſame way as they can be put in equilibrio by the interven-
52 tion of any mechanical engine.

...eriment.

Let a cloſe veſſel ABC (fig. 7.), of any form, have two upright pipes EDC, GFB, inſerted into any parts of its top, ſides, or bottom, and let water be poured into them, ſo as to ſtand in equilibrio with the horizontal ſurfaces at E, D, G, F, and let D d, F f, be horizontal lines, *it will be found* that the height of the column E d is ſenſibly equal to that of the column G f. This is a fact univerſally obſerved in whatever way the
53 pipes are inſerted.

...ved.

Now the ſurface of the water at D is undoubtedly preſſed upwards with a force equal to a column of water, having its ſurface for its baſe, and E d for its height; it is therefore prevented from riſing by ſome oppoſite force. This can be nothing but the elaſticity of the confined air preſſing it down. The very ſame thing muſt be ſaid of the ſurface at F; and thus there are two external preſſures at D and F ſet in equilibrio by the interpoſition of air. The force exerted on the ſurface D, by the preſſure of the column E d, is therefore propagated to the ſurface at F; and thus air has this characteriſtic mark of fluidity.

In this experiment the *weight* of the air is inſenſible when the veſſel is of ſmall ſize, and has no ſenſible ſhare in the preſſure reaching at D and F. But if the elevation of the point F above D is very great, the column E d *will be obſerved* ſenſibly to exceed the column G f. Thus if F be 70 feet higher than D, E d will be an inch longer than the column G f: for in this caſe there is reacting at D, not only the preſſure propagated from F, but alſo the weight of a column of air, having the ſurface at D for its baſe and 70 feet high. This is equal to the weight of a column of water one inch high.

It is by this propagation of preſſure, this *fluidity*, that the pellet is diſcharged from a child's pop-gun. It ſticks faſt in the muzzle; and he forces in another pellet at the other end, which he preſſes forward with the rammer, condenſing the air between them, and thus propagating to the other pellet the preſſure which he exerts, till the friction is overcome, and the pellet is diſcharged by the air expanding and following it.

There is a pretty philoſophical plaything which illuſtrates this property of air in a very perſpicuous manner, and which we ſhall afterwards have occaſion to conſider as converted into a moſt uſeful hydraulic machine. 54
This is what is uſually called *Hero's fountain*, having Hero's been invented by a Syracuſan of that name. It con- fountain. ſiſts of two veſſels KLMN (fig. 8.), OPQR, which are cloſe on all ſides. A tube AB, having a funnel a-top, paſſes through the uppermoſt veſſel without communicating with it, being ſoldered into its top and bottom. It alſo paſſes through the top of the under-veſſel, where it is alſo ſoldered, and reaches almoſt to its bottom. This tube is open at both ends. There is another open tube ST, which is ſoldered into the top of the under-veſſel and the bottom of the upper veſſel, and reaches almoſt to its top. Theſe two tubes ſerve alſo to ſupport the upper veſſel. A third tube GF is ſoldered into the top of the upper veſſel, and reaches almoſt to its bottom. This tube is open at both ends, but the orifice G is very ſmall. Now ſuppoſe the uppermoſt veſſel filled with water to the height EN, E e being its ſurface a little below T. Stop the orifice G with the finger, and pour in water at A. This will deſcend through AB, and compreſs the air in OQRP into leſs room. Suppoſe the water in the under veſſel to have acquired the ſurface C c, the air which formerly occupied the whole of the ſpaces OPQR and KL e E will now be contained in the ſpaces o P c C and KL e E; and its elaſticity will be in equilibrio with the weight of the column of water, whoſe baſe is the ſurface E e, and whoſe height is A c. As this preſſure is exerted in every part of the air, it will be exerted on the ſurface E e of the water of the upper veſſel; and if the pipe FG were continued upwards, the water would be ſupported in it to an height e H above E e, equal to A c. Therefore if the finger be now taken from off the orifice G, the water will ſpout up to the ſame height as if it had been immediately forced out by a column of water A c without the intervention of the air, that is, nearly to H. If inſtead of the funnel at A, the veſſel have a brim which will cauſe the water diſcharged at G to run down the pipe AB, this fountain will play till all the water in the upper veſſel is expended. The operation of this ſecond fountain will be better underſtood from fig. 9. which an intelligent reader will ſee is perfectly equivalent to fig. 8. A very powerful engine for raiſing water upon this principle has long been employed in the Hungarian mines; where the pipe AB is about 200 feet high, and the pipe FG about 120; and the condenſation is made in the upper veſſel, and communicated to the lower, at the bottom of the mine, by a long pipe. See WATER-*Works*. 55

We may now apply to air all the laws of hydroſtatics Laws of and hydraulics, in perfect confidence that their legiti- hydroſtatics appli- mate conſequences will be obſerved in all its ſituations. cable to air. We ſhall in future ſubſtitute, in place of any force acting on a ſurface of air, a column of water, mercury, or any other fluid whoſe weight is equal to this force; and as we know diſtinctly from theory what will be the conſequences of this hydroſtatic preſſure, we ſhall determine *à priori* the phenomena in air; and in caſes

where theory does not enable us to ſay with preciſion what is the effect of this preſſure, experience informs us in the caſe of water, and analogy enables us to tranſfer this to air. We ſhall find this of great ſervice in ſome caſes, which otherwiſe are almoſt deſperate in the preſent ſtate of our knowledge.

56 More refined experiments, ſuch as

From ſuch familiar and ſimple obſervations and experiments, the fluidity, the heavineſs, and elaſticity, are diſcovered of the ſubſtance with which we are ſurrounded, and which we call *air*. But to underſtand theſe properties, and completely to explain their numerous and important conſequences, we muſt call in the aid of more refined obſervations and experiments which even this ſcanty knowledge of them enables us to make; we muſt contrive ſome methods of producing with preciſion any degree of condenſation or rarefaction, of employing or excluding the gravitating preſſure of air, and of modifying at pleaſure the action of all its mechanical properties.

57 A method of compreſſing the air by

Nothing can be more obvious than a method of compreſſing a quantity of air to any degree. Take a cylinder or priſmatic tube AB (fig. 10.) ſhut at one end, and fit it with a piſton or plug C, ſo nicely that no air can paſs by its ſides. This will be beſt done in a cylindric tube by a turned ſtopper, covered with oiled leather, and fitted with a long handle CD. When this is thruſt down, the air which formerly occupied the whole capacity of the tube is *condenſed* into leſs room. The force neceſſary to produce any degree of compreſſion may be concluded from the weight neceſſary for puſhing down the plug to any depth. But this inſtrument leaves us little opportunity of making intereſting experiments on or in this condenſed air; and the force required to make any degree of compreſſion cannot be meaſured with much accuracy; becauſe the piſton muſt be very cloſe, and have great friction, in order to be ſufficiently tight: And as the compreſſion is increaſed, the leather is more ſqueezed to the ſide of the tube; and the proportion of the external force, which is employed merely to overcome this variable and uncertain friction, cannot be aſcertained with any tolerable preciſion. To get rid of theſe imperfections, the following addition may be made to the inſtrument, which then becomes what is called the *condenſing ſyringe*.

58 The condenſing ſyringe with

The end of the ſyringe is perforated with a very ſmall hole *ef*; and being externally turned to a ſmall cylinder, a narrow ſlip of bladder, or of thin leather, ſoaked in a mixture of oil and tallow, muſt be tied over the hole. Now let us ſuppoſe the piſton puſhed down to the bottom of the barrel to which it applies cloſe; when it is drawn up to the top, it leaves a void behind, and the weight of the external air preſſes on the ſlip of bladder, which therefore claps cloſe to the braſs, and thus performs the part of a valve, and keeps it cloſe ſo that no air can enter. But the piſton having reached the top of the barrel, a hole F in the ſide of it is juſt below the piſton, and the air ruſhes through this hole and fills the barrel. Now puſh the piſton down again, it immediately paſſes the hole F, and no air eſcapes through it; it therefore forces open the valve at *f*, and eſcapes while the piſton moves to the bottom.

59 Its veſſel or receiver.

Now let E be any veſſel, ſuch as a glaſs bottle, having its mouth furniſhed with a braſs cap firmly cemented to it, having a hollow ſcrew which fits a ſolid ſcrew *po*, turned on the cylindric nozzle of the ſyringe. Screw the ſyringe into this cap, and it is evident that the air forced out of the ſyringe will be accumulated in this veſſel: for upon drawing up the piſton the valve *f* always ſhuts by the elaſticity or expanding force of the air in E; and on puſhing it down again, the valve will open as ſoon as the piſton has got ſo far down that the air in the lower part of the barrel is more powerful than the air already in the veſſel. Thus at every ſtroke an additional barrelful of air will be forced into the veſſel E; and it will be found, that after every ſtroke the piſton muſt be farther puſhed down before the valve will open. It cannot open till the preſſure ariſing from the elaſticity of the air condenſed in the barrel is ſuperior to the elaſticity of the air condenſed in the veſſel; that is, till the condenſation of the firſt, or its denſity, is *ſomewhat* greater than that of the laſt, in order to overcome the ſtraining of the valve on the hole and the ſticking occaſioned by the clammy matter employed to make it air-tight.

60 A differ[ent] conſtruc[tion of] ſyringe.

Sometimes the ſyringe is conſtructed with a valve in the piſton. This piſton, inſtead of being of one piece and ſolid, conſiſts of two pieces perforated. The upper part *iknm* is connected with the rod or handle, and has its lower part turned down to a ſmall cylinder, which is ſcrewed into the lower part *klon*; and has a perforation *gh* going up in the axis, and terminating in a hole *h* in one ſide of the rod, a piece of oiled leather is ſtrained acroſs the hole *g*. When the piſton is drawn up and a void left below it, the weight of the external air forces it through the hole *hg*, opens the valve *g*, and fills the barrel. Then, on puſhing down the piſton, the air being ſqueezed into leſs room, preſſes on the valve *g*, ſhuts it; and none eſcaping through the piſton, it is gradually condenſed as the piſton deſcends till it opens the valve *f*, and is added to that already accumulated in the veſſel E.

61 Elaſtic[ity] of the a[ir] increaſ[ed] by cond[en]ſation.

Having in this manner forced a quantity of air into the veſſel E, we can make many experiments in it in this ſtate of condenſation. We are chiefly concerned at preſent with the effect which this produces on its elaſticity. We ſee this to be greatly increaſed; for we find more and more force required for introducing every ſucceſſive barrelful. When the ſyringe is unſcrewed, we ſee the air ruſh out with great violence, and every indication of great expanding force. If the ſyringe be connected with the veſſel E in the ſame manner as the ſyringe in n° 17, viz. by interpoſing a ſtopcock B between them (ſee fig. 3.), and if this ſtopcock have a pipe at its extremity, reaching near to the bottom of the veſſel, which is previouſly half filled with water, we can obſerve diſtinctly when the elaſticity of the air in the ſyringe exceeds that of the air in the receiver: for the piſton muſt be puſhed down a certain length before the air from the ſyringe bubbles up thro' the water, and the piſton muſt be farther down at each ſucceſſive ſtroke before this appearance is obſerved. When the air has thus been accumulated in the receiver, it preſſes the ſides of it outward, and will burſt it if not ſtrong enough. It alſo preſſes on the ſurface of the water; and if we now ſhut the cock, unſcrew the ſyringe, and open the cock again, the air will force the water through the pipe with great velocity, cauſing it to riſe in a beautiful jet. When a metal-receiver is uſed, the condenſation may be puſhed to a great length, and the jet will then riſe to a great height; which gradually

dually diminiſhes as the water is expended and room given to the air to expand itſelf. See the figure.

62 [M]ethod [of ju]dging [th]e con[denſ]ation,

We judge of the condenſation of air in the veſſel E by the number of ſtrokes and the proportion of the capacity of the ſyringe to that of the veſſel. Suppoſe the firſt to be one-tenth of the laſt; then we know, that after 10 ſtrokes the quantity of air in the veſſel is doubled, and therefore its denſity double, and ſo on after any number of ſtrokes. Let the capacity of the ſyringe (when the piſton is drawn to the top) be a, and that of the veſſel be b, and the number of ſtrokes be n, the denſity of air in the veſſel will be $\frac{b+na}{b}$, or $1+\frac{na}{b}$.

63 [Im]per[fectl]y accu-

But this is on the ſuppoſition that the piſton accurately fills the barrel, the bottom of the one applying cloſe to that of the other, and that no force is neceſſary for opening either of the valves: but the firſt cannot be inſured, and the laſt is very far from being true. In the conſtruction now deſcribed, it will require at leaſt one twentieth-part of the ordinary preſſure of the air to open the piſton valve: therefore the air which gets in will want at leaſt this proportion of its complete elaſticity; and there is always a ſimilar part of the elaſticity employed in opening the nozzle valve. The condenſation therefore is never nearly equal to what is here determined.

64 [B]etter [met]hod.

It is accurately enough meaſured by a gage fitted to the inſtrument. A glaſs tube GH of a cylindric bore, and cloſe at the end, is ſcrewed into the ſide of the cap on the mouth of the veſſel E. A ſmall drop of water or mercury is taken into this tube by warming it a little in the hand, which expands the contained air, ſo that when the open end is dipped into water, and the whole allowed to cool, the water advances a little into the tube. The tube is furniſhed with a ſcale divided into ſmall equal parts, numbered from the cloſe end of the tube. Since this tube communicates with the veſſel, it is evident that the condenſation will force the water along the tube, acting like a piſton on the air beyond it, and the air in the tube and veſſel will always be of one denſity. Suppoſe the number at which the drop ſtands before the condenſation is made to be c, and that it ſtands at d when the condenſation has attained the degree required, the denſity of the air in the remote end of the gage, and conſequently in the veſſel, will be $\frac{c}{d}$.

65 [V]ariation

Sometimes there is uſed any bit of tube cloſe at one end, having a drop of water in it, ſimply laid into the veſſel E, and furniſhed or not with a ſcale: but this can only be uſed with glaſs veſſels, and theſe are too weak to reſiſt the preſſure ariſing from great condenſation. In ſuch experiments metalline veſſels are uſed, fitted with a variety of apparatus for different experiments. Some of theſe will be occaſionally mentioned afterwards.

66 [Sy]nges [for g]reat [con]denſa[tion]s.

It muſt be obſerved in this place, that very great condenſations require great force, and therefore ſmall ſyringes. It is therefore convenient to have them of various ſizes, and to begin with thoſe of a larger diameter, which operate more quickly; and when the condenſation becomes fatiguing, to change the ſyringe for a ſmaller.

For this reaſon, and in general to make the condenſing apparatus more convenient, it is proper to have a ſtop-cock interpoſed between the ſyringe and the veſſel, or as it is uſually called the receiver. This conſiſts of a braſs pipe, which has a well-ground cock in its middle, and has a hollow ſcrew at one end, which receives the nozzle ſcrew of the ſyringe, and a ſolid ſcrew at the other end, which fits the ſcrew of the receiver. See fig. 3. 67 A ſtop-cock between the ſyringe and receiver.

By theſe gages, or contrivances ſimilar to them, we have been able to aſcertain very great degrees of condenſation in the courſe of ſome experiments. Dr Hales found, that when dry wood was put into a ſtrong veſſel, which it almoſt filled, and the remainder was filled with water, the ſwelling of the wood, occaſioned by its imbibition of water, condenſed the air of his gage into the thouſandth of its original bulk. He found that peaſe treated in the ſame way generated elaſtic air, which preſſing on the air in the gage condenſed it into the fifteen hundredth part of its bulk. This is the greateſt condenſation that has been aſcertained with preciſion, although in other experiments it has certainly been carried much farther; but the preciſe degree could not be aſcertained. 68 Inſtances of great condenſation prove

The only uſe to be made of this obſervation at preſent is, that ſince we have been able to exhibit air in a denſity a thouſand times greater than the ordinary denſity of the air we breathe, it cannot, as ſome imagine, be only a different form of water; for in this ſtate it it is as denſe or denſer than water, and yet retains its great expanſibility. 69 Air and water to be eſſentially different;

Another important obſervation is, that in every ſtate of denſity in which we find it, it retains its perfect fluidity, tranſmitting all preſſures which are applied to it with undiminiſhed force, as appears by the equality conſtantly obſerved between the oppoſing columns of water or other fluid by which it is compreſſed, and by the facility with which all motions are performed in it in the moſt compreſſed ſtates in which we can make obſervations of this kind. This fact is totally incompatible with the opinion of thoſe who aſcribe the elaſticity of air to the ſpringy ramified ſtructure of its particles, touching each other like ſo many pieces of ſponge or foot-balls. A collection of ſuch particles might indeed be pervaded by ſolid bodies with conſiderable eaſe, if they were merely touching each other, and not ſubjected to any external preſſure. But the moment ſuch preſſure is exerted, and the aſſemblage ſqueezed into a ſmaller ſpace, each preſſes on its adjoining particles: they are individually compreſſed, flattened in their touching ſurfaces, and *before the denſity is doubled* they are ſqueezed into the form of perfect cubes, and compoſe a maſs, which may indeed propagate preſſure from one place to another in an imperfect manner, and with great diminution of its intenſity, but will no more be fluid than a maſs of ſoft clay. It will be of uſe to keep this obſervation in mind. 70 And ſhow the error of ſome opinions reſpecting elaſticity, &c.

We have ſeen that air is heavy and compreſſible, and might now proceed to deduce in order the explanation of the appearances conſequent on each of theſe properties. But, as has been already obſerved, the elaſticity of air modifies the effects of its gravity ſo remarkably, that they would be imperfectly underſtood if both qualities were not combined in our conſideration of either. At any rate, ſome farther conſequences of its elaſticity 71 Conſequences of the air's elaſticity.

ticity muft be confidered, before we underftand the means of varying at pleafure the effects of its gravity.

72
Its great expanfibility

Since air is heavy, the lower ftrata of a mafs of air muft fupport the upper; and, being compreffible, they muft be condenfed by their weight. In this ftate of compreffion the elafticity of the lower ftrata of air acts in oppofition to the weight of the incumbent air, and balances it. There is no reafon which fhould make us fuppofe that its expanding force belongs to it only when in fuch a ftate of compreffion. It is more probable, that, if we could free it from this preffure, the air would expand itfelf into ftill greater bulk. This is moft diftinctly feen in the following experiment.

73
Proved by experiment.

Into the cylindric jar ABCD (fig. 11.), which has a fmall hole in its bottom, and is furnifhed with an air-tight pifton E, put a fmall flaccid bladder, having its mouth tied tight with a ftring. Having pufhed the pifton near to the bottom, and noticed the ftate of the bladder, ftop up the hole in the bottom of the jar with the finger, and draw up the pifton, which will require a confiderable force. You will obferve the bladder fwell out, as if air had been blown into it; and it will again collapfe on allowing the pifton to defcend. Nothing can be more unexceptionable than the conclufion from this experiment, that ordinary air is in a ftate of compreffion, and that its elafticity is not limited to this ftate. The bladder being flaccid, fhows that the included air is in the fame ftate with the air which furrounds it; and the fame muft be affirmed of it while it fwells but ftill remains flaccid. We muft conclude, that the whole air within the veffel expands, and continues to fill it, when its capacity has been enlarged. And fince this is obferved to go on as long as we give it more room, we conclude, that by fuch experiments we have not yet given it fo much room as it can occupy.

74
Attempts to difcover the limits of this expanfion by

It was a natural object of curiofity to difcover the limits of this expanfion; to know what was the natural unconftrained bulk of a quantity of air, beyond which it would not expand though all external compreffing force were removed. Accordingly philofophers conftructed inftruments for *rarefying* the air. The common water-pump had been long familiar, and appeared very proper for this purpofe. The moft obvious is the following.

75
A fyringe;

Let the barrel of the fyringe AB (fig. 12.) communicate with the veffel V, with a ftopcock C between them. Let it communicate with the external air by another orifice D, in any convenient fituation, alfo furnifhed with a ftopcock. Let this fyringe have a pifton very accurately fitted to it fo as to touch the bottom all over when pufhed down, and have no vacancy about the fides.

76
From the operation of which

Now fuppofe the pifton at the bottom, the cock C open, and the cock D fhut, draw the pifton to the top. The air which filled the veffel V will expand fo as to fill both that veffel and the barrel AB; and as no reafon can be given to the contrary, we muft fuppofe that the air will be uniformly diffufed through both. Calling V and B the capacity of the veffel and barrel, it is plain that the bulk of the air will now be V+B; and fince the quantity of matter remains the fame, and the denfity of a fluid is as its quantity of matter directly and its bulk inverfely, the denfity of the expanded air will be $\frac{V}{V+B}$, the denfity of common air being 1: for $V+B : V = 1 : \frac{V}{V+B}$.

The pifton requires force to raife it, and it is raifed in oppofition to the preffure of the incumbent atmofphere; for this had formerly been balanced by the elafticity of the common air: and we conclude from the fact, *that force is required to raife the pifton*, that the elafticity of the expanded air is lefs than that of air in its ordinary ftate; and an accurate obfervation of the force neceffary to raife it would fhow how much the elafticity is diminifhed. When therefore the pifton is let go, it will defcend as long as the preffure of the atmofphere exceeds the elafticity of the air in the barrel; that is, till the air in the barrel is in a ftate of ordinary denfity. To put it further down will require force, becaufe the air muft be compreffed in the barrel; but if we now open the cock D, the air will be expelled through it, and the pifton will reach the bottom.

77
We infe[r] the dimin[u]tion of th[e] elafticity [of] expanded air,

Now fhut the *difcharging cock* D, and open the cock C, and draw up the pifton. The air which occupied the fpace V, with the denfity $\frac{V}{V+B}$, will now occupy the fpace V+B, if it expands fo far. To have its denfity D, fay, As its prefent bulk V+B is to its former bulk V, fo is its former denfity $\frac{V}{V+B}$ to its new denfity; which will therefore be $\frac{V \times V}{V+B \times V+B}$, or $\overline{\frac{V}{V+B}}\Big|^2$.

78
And ca[lcu]late its d[en]fity.

It is evident, that if the air continues to expand, the denfity of the air in the veffel after the third drawing up of the pifton will be $\overline{\frac{V}{V+B}}\Big|^3$, after the fourth it will be $\overline{\frac{V}{V+B}}\Big|^4$, and after any number of ftrokes n will be $\overline{\frac{V}{V+B}}\Big|^n$. Thus, if the veffel is four times as large as the barrel, the denfity after the fifth ftroke will be $\frac{1024}{3125}$, nearly $\frac{1}{3}$ of its ordinary denfity. 79

On the other hand, the number n of ftrokes neceffary for reducing air to the denfity D is 80
$$\frac{\text{Log } D}{\text{Log } V - \text{Log } (V+B)}.$$

81
Some in[]conveni[]ences of this inftr[u]ment

Thus we fee that this inftrument can never abftract the whole air in confequence of its expanfion, but only rarefy it continually as long as it continues to expand; nay, there is a limit beyond which the rarefaction cannot go. When the pifton has reached the bottom, there remains a fmall fpace between it and the cock C filled with common air. When the pifton is drawn up, this fmall quantity of air expands, and alfo a fimilar quantity in the neck of the other cock; and no air will come out of the receiver V till the expanded air in the barrel is of a fmaller denfity than the air in the receiver. This circumftance evidently directs us to make thefe two fpaces as fmall as poffible, or by fome contrivance

contrivance to fill them up altogether. Perhaps this may be done effectually in the following manner.

12 ...edied ...nother

Let BE (fig. 13.) repreſent the bottom of the barrel, and let the circle HKI be the ſection of the key of the cock, of a large diameter, and place it as near to the barrel as can be. Let this communicate with the barrel by means of an hole FG widening upwards, as the fruſtum of a hollow obtuſe cone. Let the bottom of the piſton *bfbge* be ſhaped ſo as to fit the bottom of the barrel and this hole exactly. Let the cock be pierced with two holes. One of them, HI, paſſes perpendicularly through its axis, and forms the communication between the receiver and barrel. The other hole, KL, has one extremity K on the ſame circumference with H, ſo that when the key is turned a fourth part round, K will come into the place of H: but this hole is pierced obliquely into the key, and thus keeps clear of the hole HI. It goes no further than the axis, where it communicates with a hole bored along the axis and terminating at its extremity. This hole forms the communication with the external air, and ſerves for diſcharging the air in the barrel. (A ſide view of the key is ſeen in fig. 14.) Fig. 12. ſhows the poſition of the cock while the piſton is moving upwards, and fig. 14. ſhows its poſition while the piſton is moving downwards. When the piſton has reached the bottom, the conical piece *fbg* of the piſton, which may be of firm leather, fills the hole FHG, and therefore completely expels the air from the barrel. The canal KL*l* of the cock contains air of the common denſity; but this is turned aſide into the poſition KL (fig. 13.), while the piſton is ſtill touching the cock. It cannot expand into the barrel during the aſcent of the piſton. In place of it the perforation HLI comes under the piſton, filled with air that had been turned aſide with it when the piſton was at the top of the barrel, and therefore of the ſame denſity with the air of the receiver. It appears therefore that there is no limit to the rarefaction as long as the air will expand.

83 ...ed an ...uſting ...ge.

This inſtrument is called an Exhausting Syringe. It is more generally made in another form, which is much leſs expenſive, and more convenient in its uſe. Inſtead of being furniſhed with *cocks* for eſtabliſhing the communications and ſhutting them, as is neceſſary, it has *valves* like thoſe of the condenſing ſyringe, but opening in the oppoſite direction. It is thus made:

84 ...con- ...ction

The pipe of communication or conduit MN (fig. 15.), has a male ſcrew in its extremity, and over this is tied a ſlip of bladder or leather M. The lower half of the piſton has alſo a male ſcrew on it, covered at the end with a ſlip of bladder O. This is ſcrewed into the upper half of the piſton, which is pierced with a hole H coming out of the ſide of the rod.

85 ...ration.

Now ſuppoſe the ſyringe ſcrewed to the conducting pipe, and that ſcrewed into the receiver V, and the piſton at the bottom of the barrel. When the piſton is drawn up, the preſſure of the external air ſhuts the valve O, and a void is left below the piſton: there is therefore no preſſure on the upper ſide of the valve M to balance the elaſticity of the air in the receiver which formerly balanced the weight of the atmoſphere. The air therefore in the receiver lifts this valve, and diſtributes itſelf between the veſſel and the barrel; ſo that when the piſton has reached the top the denſity of the air in both receiver and barrel is as before $\frac{V}{V+B}$.

When the piſton is let go it deſcends, becauſe the elaſticity of the expanded air is not a balance for the preſſure of the atmoſphere, which therefore preſſes down the piſton with the difference, keeping the piſton-valve ſhut all the while. At the ſame time the valve M alſo ſhuts: for it was opened by the prevailing elaſticity of the air in the receiver, and while it is open the two airs have equal denſity and elaſticity; but the moment the piſton deſcends, the capacity of the barrel is diminiſhed, the elaſticity of its air increaſes by collapſing, and now prevailing over that of the air in the receiver ſhuts the valve M. 86

When it has arrived at ſuch a part of the barrel that the air in it is of the denſity of the external air, there is no force to puſh it farther down; the hand muſt therefore preſs it. This attempts to condenſe the air in the barrel, and therefore increaſes its elaſticity; ſo that it lifts the valve O and eſcapes, and the piſton gets to the bottom. When drawn up again, greater force is required than the laſt time, becauſe the elaſticity of the included air is leſs than in the former ſtroke. The piſton riſes further before the valve M is lifted up, and when it has reached the top of the barrel the denſity of the included air is $\overline{\frac{V}{V+B}}\Big|^2$. The piſton, when let go, will deſcend further than it did before ere the piſton-valve open, and the preſſure of the hand will again puſh it to the bottom, all the air eſcaping through O. The rarefaction will go on at every ſucceſſive ſtroke in the ſame manner as with the other ſyringe. 87

88 Advantages of this ſyringe over the former, and

This ſyringe is evidently more eaſy in its uſe, requiring no attendance to the cocks to open and ſhut them at the proper times. On this account this conſtruction of an exhauſting ſyringe is much more generally uſed.

89 Its inferiority.

But it is greatly inferior to the ſyringe with cocks with reſpect to its power of rarefaction. Its operation is greatly limited. It is evident that no air will come out of the receiver unleſs its elaſticity *exceed* that of the air in the barrel by a difference able to lift up the valve M. A piece of oiled leather tied acroſs this hole can hardly be made tight and certain of clapping to the hole without ſome ſmall ſtraining, which muſt therefore be overcome. It muſt be very gentle indeed not to require a force equal to the weight of two inches of water, and this is equal to about the 200th part of the whole elaſticity of the ordinary air; and therefore this ſyringe, for this reaſon alone, cannot rarefy air above 200 times, even though air were capable of an indefinite expanſion. In like manner the valve O cannot be raiſed without a ſimilar prevalence of the elaſticity of the air in the barrel above the weight of the atmoſphere. Theſe cauſes united, make it difficult to rarefy the air more than 100 times, and very few ſuch ſyringes will rarefy it more than 50 times; whereas the ſyringe with cocks, when new and in good order, will rarefy it 1000 times.

90 The former ſyringe, however, more liable to go out of order.

But, on the other hand, ſyringes with cocks are much more expenſive, eſpecially when furniſhed with apparatus for opening and ſhutting the cocks. They are more difficult to make equally tight, and (which is the

Air-pump. the greatest objection) do not remain long in good order. The cocks, by so frequently opening and shutting, grow loose, and allow the air to escape. No method has been found of preventing this. They must be ground tight by means of emery or other cutting powders. Some of these unavoidably stick in the metal, and continue to wear it down. For this reason philosophers, and the makers of philosophical instruments, have turned their chief attention to the improvement of the syringe with valves. We have been thus minute in the account of the operation of rarefaction, that the reader may better understand the value of these improvements, and in general the operation of the principal pneumatic engines.

Of the Air-Pump.

91 Invention of the air-pump by Guericke. An Air-Pump is nothing but an exhausting syringe accommodated to a variety of experiments. It was first invented by Otto Guericke, a gentleman of Magdeburgh in Germany, about the year 1654. We trust that it will not be unacceptable to our readers to see this instrument, which now makes a principal article in a philosophical apparatus, in its first form, and to trace it through its successive steps to its present state of improvement.

Guericke, indifferent about the solitary possession of an invention which gave entertainment to numbers who came to see his wonderful experiments, gave a minute description of all his pneumatic apparatus to Gaspar Schottus professor of mathematics at Wirtemberg, who immediately published it with the author's consent, with an account of some of its performances, first in 1657, in his *Mechanica Hydraulico-pneumatica*; and then in his *Technica Curiosa*, in 1664, a curious collection of all the wonderful performances of art which he collected by a correspondence over all Europe.

92 Construction of his pump. Otto Guericke's air-pump consists of a glass receiver A (fig. 16.), of a form nearly spherical, fitted up with a brass cap and cock B. The nozzle of the cap was fixed to a syringe CDE, also of brass, bent at D into half a right angle. This had a valve at D, opening from the receiver into the syringe, and shutting when pressed in the opposite direction. In the upper side of the syringe there is another valve F, opening from the syringe into the external air, and shutting when pressed inwards. The piston had no valve. The syringe, the cock B, and the joint of the tube, were immersed in a cistern filled with water. From this description it is easy to understand the operation of the instrument. When the piston was drawn up from the bottom of the syringe, the valve F was kept shut by the pressure of the external air, and the valve D opened by the elasticity of the air in the receiver. When it was pushed down again, the valve D immediately shut by the superior elasticity of the air in the syringe; and when this was sufficiently compressed, it opened the valve F, and was discharged. It was immersed in water, that no air might find its way through the joints or cocks.

93 Its imperfections. It would seem that this machine was not very perfect, for Guericke says that it took several hours to produce an evacuation of a moderate-sized vessel; but he says, that when it was in good order, the rarefaction (for he acknowledges that it was not, nor could be, a complete evacuation) was so great, that when the cock was opened, and water admitted, it filled the receiver so as sometimes to leave no more than the bulk of a pea filled with air. This is a little surprising; for if the valve F be placed as far from the bottom of the syringe as in Schottus's figure, it would appear that the rarefaction could not be greater than what must arise from the air in DF expanding till it filled the whole syringe: because as soon as the piston in its descent passes F it can discharge no more air, but must compress it between F and the bottom, to be expanded again when the piston is drawn up. It is probable that the piston was not very tight, but that on pressing it down it allowed the air to pass it; and the water in which the whole was immersed prevented the return of the air when it was drawn up again: and this accounts for the great time necessary for producing the desired rarefaction.

Guericke, being a gentleman of fortune, spared no expence, and added a part to the machine, which saved his numerous visitants the trouble of hours attendance before they could see the curious experiments with the rarefied air. He made a large copper vessel G (fig. 17.), having a pipe and cock below, which passed through the floor of the chamber into an under apartment, where it was joined to the syringe immersed in the cistern of water, and worked by a lever. The upper part of the vessel terminated in a pipe, furnished with a stopcock H, surrounded with a small brim to hold water for preventing the ingress of air. On the top was another cap I, also filled with water, to protect the junction of the pipes with the receiver K. This great vessel was always kept exhausted, and workmen attended below. When experiments were to be performed in the receiver K, it was set on the top of the great vessel, and the cock H was opened. The air in K immediately diffused itself equally between the two vessels, and was so much more rarefied as the receiver K was smaller than the vessel G. When this rarefaction was not sufficient, the attendants below immediately worked the pump. 94 His improvement of it.

These particulars deserve to be recorded, as they show the inventive genius of this celebrated philosopher, and because they are useful even in the present advanced state of the study. Guericke's method of excluding air from all the joints of his apparatus, by immersing these joints in water, is the only method that has to this day been found effectual; and there frequently occur experiments where this exclusion for a long time is absolutely necessary. In such cases it is necessary to construct little cups or cisterns at every joint, and to fill them with water or oil. In a letter to Schottus, 1662-3, he describes very ingenious contrivances for producing complete rarefaction after the elasticity of the remaining air has been so far diminished that it is not able to open the valves. He opens the exhausting valves by a plug, which is pushed in by the hand; and the discharging valve is opened by a small pump placed on its outside, so that it opens into a void instead of opening against the pressure of the atmosphere. (See *Schotti Technica Curiosa*, p. 68, 70.) These contrivances have been lately added to air-pumps by Haas and Hurter as new inventions.

It must be acknowledged, that the application of the pump or syringe to the exhaustion of air was a very obvious thought on the principle exhibited in nº 17. and in this way it was also employed by Guericke, who first filled the receiver with water, and then applied the syringe. But this was by no means either his object or his

pump. his principle. His object was not solely to procure a vessel void of air, but to exhaust the air which was already in it; and his principle was the power which he suspected to be in air of expanding itself into a greater space when the force was removed which he supposed to compress it. He expressly says *(Tract. de Experimentis Magdeburgicis, et in Epist. ad Schottum)*, that the contrivance occurred to him accidentally when occupied with experiments in the Toricellian tube, in which he found that the air would really expand, and completely fill a much larger space than what it usually occupied, and that he had found no limits to the expansion, evincing this by facts which we shall perfectly understand by and by. This was a doctrine quite new, and required a philosophical mind to view it in a general and systematic manner; and it must be owned that his manner of treating the subject is equally remarkable for ingenuity and for modesty. *(Epist. ad Schottum.)*

95 ...its of ...ricke.

96 ...gress of ...erimen... ...hiloso...

His doctrine and his machine were soon spread over Europe. It was the age of literary ardour and philosophical curiosity; and it is most pleasant to us, who, standing on the shoulders of our predecessors, can see far around us, to observe the eagerness with which every new, and to us frivolous, experiment was repeated and canvassed. The worshippers of Aristotle were daily receiving severe mortifications from the experimenters, or empirics as they affected to call them, and they exerted themselves strenuously in support of his now tottering cause. This contributed to the rapid propagation of every discovery; and it was a most profitable and respectable business to go through the chief cities of Germany and France exhibiting philosophical experiments.

97 ...our of Boyle.

About this time the foundations of the Royal Society of London were laid. Mr Boyle, Mr Wren, Lord Brounker, Dr Wallis, and other curious gentlemen, held meetings at Oxford, in which were received accounts of whatever was doing in the study of nature; and many experiments were exhibited. The researches of Galileo, Toricelli, and Paschal concerning the pressure of the air, greatly engaged their attention, and many additions were made to their discoveries. Mr Boyle, the most ardent and succesful studier of nature, had the principal share in these improvements, his inquisitive mind being aided by an opulent fortune. In a letter to his nephew Lord Dungarvon, he says that he had made many attempts to see the appearances exhibited by bodies freed from the pressure of the air. He had made Toricellian tubes, having a small vessel a-top, into which he put some bodies before filling the tubes with mercury; so that when the tube was set upright, and the mercury run out, the bodies were *in vacuo*. He had also abstracted the water from a vessel, by a small pump, by means of its weight, in the manner described in n° 17, having previously put bodies into the vessel along with the water. But all these ways were very troublesome and imperfect. He was delighted when he learned from Schottus's first publication, that Counsellor Guericke had effected this by the expansive power of the air; and immediately set about constructing a machine from his own ideas, no description of Guericke's being then published.

...late CCI.

It consisted of a receiver A (fig. 18.), furnished with a stopcock B, and syringe CD placed in a vertical position below the receiver. Its valve C was in its bottom, close adjoining to the entry of the pipe of communication; and the hole by which the air issued was farther secured by a plug which could be removed. The piston was moved by a wheel and rackwork. The receiver of Guericke's pump was but ill adapted for any considerable variety of experiments; and accordingly very few were made in it. Mr Boyle's receiver had a large opening EF, with a strong glass margin. To this was fitted a strong brass cap, pierced with a hole G in its middle, to which was fitted a plug ground into it, and shaped like the key of a cock. The extremity of this key was furnished with a screw, to which could be affixed a hook, or a variety of pieces for supporting what was to be examined in the receiver, or for producing various motions within it, without admitting the air. This was farther guarded against by means of oil poured round the key, where it was retained by the hollow cup-like form of the cover. With all these precautions, however, Mr Boyle ingenuously confesses, that it was but seldom, and with great difficulty, that he could produce an extreme degree of rarefaction; and it appears by Guericke's letter to Schottus, that in this respect the Magdeburgh machine had the advantage. But most of Boyle's very interesting experiments did not require this extreme rarefaction; and the variety of them, and their philosophic importance, compensated for this defect, and soon eclipsed the fame of the inventor to such a degree, that the state of air in the receiver was generally denominated the *vacuum Boyleanum*, and the air-pump was called *machina Boyleana*. It does not appear that Guericke was at all solicitous to maintain his claim to priority or invention. He appears to have been of a truly noble and philosophical mind, aiming at nothing but the advancement of science.

Air-pump.

98 His air-pump.

99 His contrivances to make air-vessels tight.

Mr Boyle found, that to make a vessel air-tight, it was sufficient to place a piece of wet or oiled leather on its brim, and to lay a flat plate of metal upon this. The pressure of the external air squeezed the two solid bodies so hard together, that the soft leather effectually excluded it. This enabled him to render the whole machine incomparably more convenient for a variety of experiments. He caused the conduit-pipe to terminate in a flat plate which he covered with leather, and on this he set the glass ball or receiver, which had both its upper and lower brim ground flat. He covered the upper orifice in like manner with a piece of oiled leather and a flat plate, having cocks and a variety of other perforations and contrivances suited to his purposes. This he found infinitely more expeditious, and also tighter, than the clammy cements which he had formerly used for securing the joints.

100 Dr Hooke's improvement of Boyle's air-pump

He was now assisted by Dr Hooke, the most ingenious and inventive mechanic that the world has ever seen. This person made a great improvement on the air-pump, by applying two syringes whose piston-rods were worked by the same wheel, as in fig. 20, n° 1, and putting valves in the pistons in the same manner as in the piston of a common pump. This evidently doubled the expedition of the pump's operation: but it also greatly diminished the labour of pumping; for it must be observed, that the piston H must be drawn up against the pressure of the external air, and when the rarefaction is nearly perfect this requires a force of nearly 15 pounds for every inch of the area of the piston. Now when one piston H is at the bottom of the barrel, the other K is at the

Air-pump. the top of the barrel, and the air below K is equally rare with that in the receiver. Therefore the pressure of the external air on the piston K is *nearly* equal to that on the piston H. Both, therefore, are acting in opposite directions on the wheel which gave them motion; and the force necessary for raising H is only the difference between the elasticity of the air in the barrel H and that of the air in the barrel K. This is very small in the beginning of the stroke, but gradually increases as the piston K descends, and becomes equal to the whole excess of the air's pressure above the elasticity of the remaining air of the receiver when the air at K of the natural density begins to open the piston valves. An accurate attention to the circumstances will show us that the force requisite for working the pump is greatest at first, and gradually diminishes as the rarefaction advances; and when this is nearly complete, hardly any more force is required than what is necessary for overcoming the friction of the pistons, except during the discharge of the air at the end of each stroke.

101 Generally adopted.

This is therefore the form of the air-pump which is most generally used all over Europe. Some traces of national prepossession remain. In Germany, air-pumps are frequently made after the original model of Guericke's (Wolff Cyclomathesis); and the French generally use the pump made by Papin, though extremely aukward. We shall give a description of Boyle's air-pump as finally improved by Hawkesbee, which, with some small accommodations to particular views, still remains the most approved form.

102 Hawkesbee's improvements. Plate CCCCI.

Here follows the description from Desaguliers.

It consists of two brass barrels *a a*, *a a* (fig. 19.), 12 inches high and 2 wide. The pistons are raised and depressed by turning the winch *b b*. This is fastened to an axis passing through a strong toothed wheel, which lays hold of the teeth of the racks *c c c c*. Then the one is raised while the other is depressed; by which means the valves, which are made of limber bladder, fixed in the upper part of each piston, as well as in the openings into the bottom of the barrels, perform their office of discharging the air from the barrels, and admitting into them the air from the receiver to be afterwards discharged; and when the receiver comes to be pretty well exhausted of its air, the pressure of the atmosphere in the descending piston is nearly so great, that the power required to raise the other is little more than is necessary for overcoming the friction of the piston, which renders this pump preferable to all others, which require more force to work them as the rarefaction of the air in the receiver advances.

103 Barrels.

The barrels are set in a brass dish about two inches deep, filled with water or oil to prevent the insinuation of air. The barrels are screwed tight down by the nuts *e e*, *e e*, which force the frontispiece *f f* down on them, through which the two pillars *g g*, *g g* pass.

104 Brass pipe, &c.

From between the barrels rises a slender brass pipe *h h*, communicating with each by a perforation in the transverse piece of brass on which they stand. The upper end of this pipe communicates with another perforated piece of brass, which screws on underneath the plate *i i i i*, of ten inches diameter, and surrounded with a brass rim to prevent the shedding of water used in some experiments. This piece of brass has three branches: 1st, An horizontal one communicating with the conduit-pipe *h h*. 2. An upright one screwed into the middle of the pump-plate, and terminating in a small pipe *k*, rising about an inch above it. 3d, Is a perpendicular one, looking downwards in the continuation of the pipe *k*, and having a hollow screw in its end receiving the brass cap of the gage-pipe *l l l l*, which is of glass, 34 inches long, and immersed in a glass cistern *m m* filled with mercury. This is covered a-top with a cork float, carrying the weight of a light wooden scale divided into inches, which are numbered from the surface of the mercury in the cistern. This scale will therefore rise and fall with the mercury in the cistern, and indicate the true elevation of that in the tube.

105 Stopcock.

There is a stopcock immediately above the insertion of the gage-pipe, by which its communication may be cut off. There is another at *n*, by which a communication is opened with the external air for allowing its readmission; and there is sometimes another immediately within the insertion of the conduct-pipe for cutting off the communication between the receiver and the pump. This is particularly useful when the rarefaction is to be continued long, as there are by these means fewer chances of the insinuation of air by the many joints.

106 Receivers.

The receivers are made tight by simply setting them on the pump-plate with a piece of wet or oiled leather between; and the receivers, which are open a-top, have a brass cover set on them in the same manner. In these covers there are various perforations and contrivances for various purposes. The one in the figure has a slip wire passing through a collar of oiled leather, having a hook or a screw in its lower end for hanging any thing on or producing a variety of motions.

107 Contrivance for removing them.

Sometimes the receivers are set on another plate, which has a pipe screwed into its middle, furnished with a stopcock and a screw, which fits the middle pipe *k*. When the rarefaction has been made in it, the cock is shut, and then the whole may be unscrewed from the pump, and removed to any convenient place. This is called a *transporter plate*.

108 Principle upon which the gage is constructed.

It only remains to explain the gage *l l l l*. In the ordinary state of the air its elasticity balances the pressure of the incumbent atmosphere. We find this from the force that is necessary to squeeze it into less bulk, in opposition to this elasticity. Therefore the elasticity of the air increases with the vicinity of its particles. It is therefore reasonable to expect, that when we allow it to occupy more room, and its particles are farther asunder, its elasticity will be diminished though not annihilated; that is, it will no longer balance the WHOLE pressure of the atmosphere, though it may still balance part of it. If therefore an upright pipe have its lower end immersed in a vessel of mercury, and communicate by its upper end with a vessel containing rarefied, therefore less elastic, air, we should expect that the pressure of the air will prevail, and force the mercury into the tube, and cause it to rise to such an height that the weight of the mercury, joined to the elasticity of the rarefied air acting on its upper surface, shall be exactly equal to the whole pressure of the atmosphere. The height of the mercury is the exact measure of that part of the whole pressure which is not balanced by the elasticity of the rarefied air, and its deficiency from the height of the mercury in the Toricellian tube is the exact measure of this remaining elasticity.

It

It is evident therefore, that the pipe will be a ſcale of the elaſticity of the remaining air, and will indicate in ſome ſort the degree of rarefaction: for there muſt be ſome analogy between the denſity of the air and its elaſticity; and we have no reaſon to imagine that they do not increaſe and diminiſh together, although we may be ignorant of the law, that is, of the change of elaſticity correſponding to a known change of denſity. This is to be diſcovered by experiment; and the air-pump itſelf furniſhes us with the beſt experiments for this purpoſe. After rarefying till the mercury in the gage has attained half the height of that in the Toricellian tube, ſhut the communication with the barrels and gage, and admit the water into the receiver. It will go in till all is again in equilibrio with the preſſure of the atmoſphere; that is, till the air in the receiver has collapſed into its natural bulk. This we can accurately meaſure, and compare with the whole capacity of the receiver; and thus obtain the preciſe degree of rarefaction correſponding to half the natural elaſticity. We can do the ſame thing with the elaſticity reduced to one third, one fourth, &c. and thus diſcover the whole law.

109 So as to indicate the degree of rarefaction.

110 Inconveniences of this gage

This gage muſt be conſidered as one of the moſt ingenious and convenient parts of Hawkeſbee's pump; and it is well diſpoſed, being in a ſituation protected againſt accidents: but it neceſſarily increaſes greatly the ſize of the machine, and cannot be applied to the table-pump, repreſented in fig. 20, n° 1. When it is wanted here, a ſmall plate is added behind, or between the barrels and receiver; and on this is ſet a ſmall tubulated (as it is termed) receiver, covering a common weather-glaſs tube.—This receiver being rarefied along with the other, the preſſure on the mercury in the ciſtern ariſing from the elaſticity of the remaining air is diminiſhed ſo as to be no longer able to ſupport the mercury at its full height; and it therefore deſcends till the height at which it ſtands puts it in equilibrio with the elaſticity. In this form, therefore, the height of the mercury is directly a meaſure of the remaining elaſticity; while in the other it meaſures the remaining unbalanced preſſure of the atmoſphere. But this gage is extremely cumberſome, and liable to accidents. We are ſeldom much intereſted in the rarefaction till it is great: a contracted form of this gage is therefore very uſeful, and was early uſed. A ſyphon ABCD (fig. 20, n° 2), each branch of which is about four inches long, cloſe at A and open at D, is filled with boiling mercury till it occupies the branch AB and a very ſmall part of CD, having its ſurface at O. This is fixed to a ſmall ſtand, and fixed into the receiver, along with the things that are to be exhibited in the rarefied air. When the air has been rarefied till its remaining elaſticity is not able to ſupport the column BA, the mercury deſcends in AB, and riſes in CD, and the remaining elaſticity will always be meaſured by the elevation of the mercury in AB above that in the leg CD. Could the exhauſtion be perfected, the ſurfaces in both legs would be on a level. Another gage might be put into the ſame foot, having a ſmall bubble of air at A. This would move from the beginning of the rarefaction; but our ignorance of the analogy between the denſity and elaſticity hinders us from uſing it as a meaſure of either.

Plate CCCCI.

111 Remedied.

It is enough for our preſent purpoſe to obſerve, that the barometer or ſyphon gage is a perfect indication and meaſure of the performance of an air-pump, and that a pump is (*cæteris paribus*) ſo much the more perfect, as it is able to raiſe the mercury higher in the gage. It is in this way that we diſcover that none can produce a complete exhauſtion, and that their operation is only a very great rarefaction: for none can raiſe the mercury to that height at which it ſtands in the Toricellian tube, well purged of air. Few pumps will bring it within $\frac{1}{10}$ of an inch. Hawkeſbee's, fitted up according to his inſtructions, will ſeldom bring it within $\frac{1}{5}$. Pumps with cocks, when conſtructed according to the principles mentioned when ſpeaking of the exhauſting ſyringe, and new and in fine order, will in favourable circumſtances bring it within $\frac{1}{40}$. None with valves fitted up with wet leather, or when water or volatile fluids are allowed acceſs into any part, will bring it nearer than $\frac{1}{5}$. Nay, a pump of the beſt kind, and in the fineſt order, will have its rarefying power reduced to the loweſt ſtandard, as meaſured by this gage, if we put into the receiver the tenth part of a ſquare inch of white ſheep-ſkin, freſh from the ſhops, or of any ſubſtance equally damp. This is a diſcovery made by means of the improved air-pump, and leads to very extenſive and important conſequences in general phyſics; ſome of which will be treated of under this article: and the obſervation is made thus early, that our readers may better underſtand the improvements which have been made on this celebrated machine.

112 A complete exhauſtion not affected by the air-pump.

It would require a volume to deſcribe all the changes which have been made on it. An inſtrument of ſuch multifarious uſe, and in the hands of curious men, each diving into the ſecrets of nature in his favourite line, muſt have received many alterations and real improvements in many particular reſpects. But theſe are beſide our preſent purpoſe; which is to conſider it merely as a machine for rarefying elaſtic or expanſive fluids. We muſt therefore confine ourſelves to this view of it; and ſhall carefully ſtate to our readers every improvement founded on principle, and on pneumatical laws.

113 Various improvements of this machine,

All who uſed it perceived the limit ſet to the rarefaction by the reſiſtance of the valves, and tried to perfect the conſtruction of the cocks. The Abbé Nollet and Graveſande, two of the moſt eminent experimental philoſophers in Europe, were the moſt ſucceſsful.

114 By attempting to perfect the conſtruction of the cocks.

Mr Graveſande juſtly preferred Hooke's plan of a double pump, and contrived an apparatus for turning the cocks by the motion of the pump's handle. This is far from either being ſimple or eaſy in working; and occaſions great jerks and concuſſions in the whole machine. This, however, is not neceſſarily connected with the truly pneumatical improvement. His piſton has no valve, and the rod is connected with it by a ſtirrup D (fig. 21), as in a common pump. The rod has a cylindric part *c p*, which paſſes through the ſtirrup, and has a ſtiff motion in it up and down of about half an inch; being ſtopped by the ſhoulder *c* above and the nut below. The round plate ſupported by this ſtirrup has a ſhort ſquare tube *n d*, which fits tight into the hole of a piece of cork F. The round plate E has a ſquare ſhank *g*, which goes into the ſquare tube *n d*. A piece of thin leather *f*, ſoaked in oil, is put between the cork and the plate E, and another between the cork and the plate which forms the ſole of the ſtirrup. All theſe pieces are ſcrewed together by the nail *e*, whoſe flat head covers the hole *n*. Suppoſe, therefore, the piſton

115 Graveſande's improvement,

Air-pump.

touching the bottom of the barrel, and the winch turning to raiſe it again, the friction of the piſton on the barrel keeps it in its place, and the rod is drawn up through the ſtirrup D. Thus the wheel has liberty to turn about an inch; and this is ſufficient for turning the cock, ſo as to cut off the communication with the external air, and to open the communication with the receiver. This being done, and the motion of the winch continued, the piſton is raiſed to the top of the barrel. When the winch is turned in the oppoſite direction, the piſton remains fixed till the cock is turned, ſo as to ſhut the communication with the receiver, and open that with the external air.

116 And manner of uſing it.

117 A uſeful contrivance.

This is a pretty contrivance, and does not at firſt appear neceſſary; becauſe the cocks might be made to turn at the beginning and end of the ſtroke without it. But this is juſt poſſible; and the ſmalleſt error of adjuſtment, or wearing of the apparatus, will cauſe them to be open at improper times. Beſides, the cocks are not turned in an inſtant, and are improperly open during ſome very ſmall time; but this contrivance completely obviates this difficulty.

118. The cock is preciſely ſimilar to that formerly deſcribed, having one perforation diametrically through it and another entering at right angles to this, and after reaching the centre, it paſſes along the axis of the cock, and comes out to the open air.

119 Its inconveniences

It is evident, that by this conſtruction of the cock, the ingenious improvement of Dr Hooke, by which the preſſure of the atmoſphere on one piſton is made to balance (in great part) the preſſure on the other, is given up: for, whenever the communication with the air is opened, it ruſhes in, and immediately balances the preſſure on the upper ſide of the piſton in this barrel; ſo that the whole preſſure in the other muſt be overcome by the perſon working the pump.

120 Remedied.

Graveſande, aware of this, put a valve on the orifice of the cock; that is, tied a ſlip of wet bladder or oiled leather acroſs it; and now the piſton is preſſed down, as long as the air in the barrel is rarer than the outward air, in the ſame manner as when the valve is in the piſton itſelf.

121 Highly extolled, but

This is all that is neceſſary to be deſcribed in Mr Graveſande's air-pump. Its performance is highly extolled by him; as far exceeding his former pumps with valves. The ſame preference was given to it by his ſucceſſor Muſchenbroek. But, while they both prepared the piſtons and valves and leathers of the pump, by ſteeping them in oil, and then in a mixture of water and ſpirits of wine, we are certain that no juſt eſtimate could be made of its performance. For with this preparation it could not bring the gage within $\frac{1}{5}$ of an inch of the barometer.

122 Limited in its operation.

We even ſee other limits to its rarefaction: from its conſtruction, it is plain that a very conſiderable ſpace is left between the piſton and cock, not leſs than an inch, from which the air is never expelled; and if this be made extremely ſmall, it is plain that the pump muſt be worked very ſlow, otherwiſe there will not be time for the air to diffuſe itſelf from the receiver into the barrel, eſpecially towards the end, when the expelling force, viz. the elaſticity of the remaining air, is very ſmall. There is alſo the ſame limit to the rarefaction, as in Hooke's or Hawkeſbee's pump, oppoſed by the valve E, which will not open till the air below the piſton is conſiderably denſer than the external air: and this pump ſoon loſt any advantages it poſſeſſed when freſh from the workman's hands, by the cock's growing looſe and admitting air.

123 In one reſpect inferior to Hawkeſbee's.

It is ſurpriſing that Graveſande omitted Hawkeſbee's ſecurity againſt this, by placing the barrels in a diſh filled with oil; which would effectually have prevented this inconvenience.

124 Advantage of ſhort barrels.

We muſt not omit a ſeemingly paradoxical obſervation of Graveſande, that in a pump conſtructed with valves, and worked with a determined uniform velocity, the required degree of rarefaction is ſooner produced by ſhort barrels than by long ones. It would require too much time to give a general demonſtration of this, but it will eaſily be ſeen by an example. Suppoſe the long barrel to have equal capacity with the receiver, then at the end of the firſt ſtroke the air in the receiver will have $\frac{1}{2}$ its natural denſity. Now, let the ſhort barrels have half this capacity: at the end of the firſt ſtroke the denſity of the air in the receiver is $\frac{2}{3}$, and at the end of the ſecond ſtroke it is $\frac{4}{9}$, which is leſs than $\frac{1}{2}$, and the two ſtrokes of the ſhort barrel are ſuppoſed to be made in the ſame time with one of the longeſt, &c.

125 Smeaton improves the valve pump

Hawkeſbee's pump maintained its pre-eminence without rival in Britain, and generally too on the continent, except in France, where every thing took the *ton* of the Academy, which abhorred being indebted to foreigners for any thing in ſcience, till about the year 1750, when it engaged the attention of Mr John Smeaton, a perſon of uncommon knowledge, and ſecond to none but Dr Hooke in ſagacity and mechanical reſource. He was then a maker of philoſophical inſtruments, and made many attempts to perfect the pumps with cocks, but found, that whatever perfection he could bring them to, he could not enable them to preſerve it; and he never would ſell one of this conſtruction. He therefore attached himſelf ſolely to the valve pumps.

126 By enlarging the valve-hole

The firſt thing was to diminiſh the reſiſtance to the entry of the air from the receiver into the barrels: this he rendered almoſt nothing, by enlarging the ſurface on which this feebly elaſtic air was to preſs. Inſtead of making theſe valves to open by its preſſure on a circle of $\frac{1}{20}$ of an inch in diameter, he made the valve-hole one inch in diameter, enlarging the ſurface 400 times; and, to prevent this piece of thin leather from being burſt by the great preſſure on it, when the piſton in its deſcent was approaching the bottom of the barrel, he ſupported it by a delicate but ſtrong grating, dividing the valve-hole like the ſection of a honey-comb, as repreſented in fig. 22, n° 3; and the ribs of this grating are ſeen edgewiſe in fig. 22, n° 1, at *a b c*.

Plate CCCC

127 Changing the ſtructure of the valve, and

The valve was a piece of thin membrane or oiled ſilk, gently ſtrained over the mouth of the valve-hole, and tied on by a fine ſilk thread wound round it in the ſame manner that the narrow ſlips had been tied on formerly. This done, he cut with a pointed knife the leather round the edge, nearly four quadrantal arcs, leaving a ſmall tongue between each, as in fig. 22, n° 3. The ſtrained valve immediately ſhrinks inwards, as repreſented by the ſhaded parts; and the ſtrain by which it is kept down is now greatly diminiſhed, taking place only at the corners. The gratings being reduced nearly to an edge (but not quite, leſt they ſhould cut), there is very little preſſure to produce adheſion by the clammy oil. Thus it appears, that a very ſmall elaſticity of the air in the receiver will be ſufficient to raiſe the valve; and Mr Smeaton found, that

Air-pump. that when it was not able to do this at first, when only about $\frac{1}{600}$ of the natural elasticity, it would do it after keeping the piston up eight or ten seconds, the air having been all the while undermining the valve, and gradually detaching it from the grating.

Unfortunately he could not follow this method with the piston valve. There was not room round the rod for such an expanded valve; and it would have obliged him to have a great space below the valve, from which

128 Increasing the expelling force.

he could not expel the air by the descent of the piston. His ingenuity hit on a way of increasing the expelling force through the common valve: he inclosed the rod of the piston in a collar of leather *l*, through which it moved freely without allowing any air to get past its sides. For greater security, the collar of leather was contained in a box terminating in a cup filled with oil. As this makes a material change in the principle of construction of the air-pump (and indeed of pneumatic engines in general), and as it has been adopted in all the subsequent attempts to improve them, it merits a particular consideration.

129 Structure of this piston for the purpose. Plate CCCL.

The piston itself consists of two pieces of brass fastened by screws from below. The uppermost, which is of one solid piece with the rod GH (fig. 22, n° 1.), is of a diameter somewhat less than the barrel; so that when they are screwed together, apiece of leather soaked in a mixture of boiled oil and tallow, is put between them; and when the piston is thrust into the barrel from above, the leather comes up around the side of the piston, and fills the barrel, making the piston perfectly air-tight. The lower half of the piston projects upwards into the upper, which has a hollow *g b c g* to receive it There is a small hole through the lower half at *a* to admit the air; and a hole *c d* in the upper half to let it through, and there is a slip of oiled silk strained across the hole *a* by way of valve, and there is room enough left at *b c* for this valve to rise a little when pressed from below. The rod GH passes through the piece of brass which forms the top of the barrel so as to move freely, but without any sensible shake: this top is formed into a hollow box, consisting of two pieces ECDF and CNOD, which screw together at CD. This box is filled with rings of oiled leather exactly fitted to its diameter, each having a hole in it for the rod to pass through. When the piece ECDF is screwed down, it compresses the leathers; squeezing them to the rod, so that no air can pass between them; and, to secure us against all ingress of air, the upper part is formed into a cup EF, which is kept filled with oil.

The top of the barrel is also pierced with a hole LK, which rises above the flat surface NO, and has a slip of oiled silk tied over it to act as a valve; opening when pressed from below, but shutting when pressed from above.

The communication between the barrel and receiver is made by means of the pipe ABPQ; and there goes from the hole K in the top of the barrel a pipe KRST, which either communicates with the open air or with the receiver, by means of the cock at its extremity T. The conduit pipe ABPQ has also a cock at Q, by which it is made to communicate either with the receiver or with the open air. These channels of communication are variously conducted and terminated, according to the views of the maker: the sketch in this figure is sufficient for explaining the principle, and is suited to the general form of the pump, as it has been frequently made by Nairne and other artists in London.

Let us now suppose the piston at the top of the barrel, and that it applies to it all over, and that the air in the barrel is very much rarefied: in the common pump the piston valve is pressed hard down by the atmosphere, and continues shut till the piston gets far down, condenses the air below it beyond its natural state, and enables it to force up the valves. But here, as soon as the piston quits the top of the barrel, it leaves a void behind it; for no air gets in round the piston rod, and the valve at K is shut by the pressure of the atmosphere. There is nothing now to oppose the elasticity of the air below but the stiffness of the valve *b c*; and thus the expelling (or more accurately the liberating) force is prodigiously increased.

130 Superiority of this construction.

The superiority of this construction will be best seen by an example. Suppose the stiffness of the valve equal to the weight of $\frac{1}{10}$ of an inch of mercury, when the barometer stands at 30 inches, and that the the pump gage stands at 29.9; then, in an ordinary pump, the valve in the piston will not rise till the piston has got within the 300th part of the bottom of the barrel, and it will leave the valve-hole filled with air of the ordinary density. But in this pump the valve will rise as soon as the piston quits the top of the barrel; and when it is quite down, the valve-hole *a* will contain only the 300th part of the air which it would have contained in a pump of the ordinary form. Suppose further, that the barrel is of equal capacity with the receiver, and that both pumps are so badly constructed, that the space left below the piston is the 300th part of the barrel. In the common pump the piston valve will rise no more, and the rarefaction can be carried no farther, however delicate the barrel valve may be; but in this pump the next stroke will raise the gage to 29.95, and the piston valve will again rise as soon as the piston gets half way down the barrel.

131 Shown by an example.

The limit to the rarefaction by this pump depends chiefly on the space contained in the hole LK; and in the space *bcd* of the piston. When the piston is brought up to the top, and applied close to it, those spaces remain filled with air of the ordinary density, which will expand as the piston descends, and thus will retard the opening of the piston valve. The rarefaction will stop when the elasticity of this small quantity of air, expanded so as to fill the whole barrel (by the descent of the piston to the bottom), is just equal to the force requisite for opening the piston valve.

132 It is easily worked.

Another advantage attending this construction is, that in drawing up the piston, we are not resisted by the whole pressure of the air; because the air is rarefied above this piston as well as below it, and the piston is in precisely the same state of pressure as if connected with another piston in a double pump. The resistance to the ascent of the piston is the excess of the elasticity of the air above it over the elasticity of the air below: this, toward the end of the rarefaction, is very small, while the piston is near the bottom of the barrel, but gradually increases as the piston rises, and reduces the air above it into smaller dimensions, and becomes equal to the pressure of the atmosphere, when the air above the piston is of the common density. If we should raise the piston still farther, we must condense the air above it: but Mr Smeaton has here made an issue for the air by a small hole in the top of the barrel, covered with a delicate

Air pump. delicate valve. This allows the air to escape, and shuts again as soon as the piston begins to descend, leaving almost a perfect void behind it as before.

This pump has another advantage. It may be changed in a moment from a rarefying to a condensing engine, by simply turning the cocks at Q and T. While T communicates with the open air and Q with the receiver, it is a rarefying engine or air-pump: but when T communicates with the receiver, and Q with the open air, it is a condensing engine.

Plate CCCCII. 133 Description of Smeaton's pump.

Fig. 23. represents Mr Smeaton's air-pump as it is usually made by Nairne. Upon a solid base or table are set up three pillars F, H, H: the pillar F supports the pump-plate A; and the pillars H, H, support the front or head, containing a brass cog-wheel, which is turned by the handle B, and works in the rack C fastened to the upper end of the piston rod. The whole is still farther steadyed by two pieces of brass *c b* and *o k*, which connect the pump-plate with the front, and have perforations communicating between the hole *a* in the middle of the plate and the barrel, as will be described immediately. DE is the barrel of the pump, firmly fixed to the table by screws thro' its upper flanch: *e f d c* is a slender brass tube screwed to the bottom of the barrel, and to the under hole of the horizontal canal *c b*. In this canal there is a cock which opens a communication between the barrel and the receiver, when the key is in the position represented here: but when the key is at right angles with this position, this communication is cut off. If that side of the key which is here drawn next to the pump-plate be turned outward, the external air is admitted into the receiver; but if turned inwards, the air is admitted into the barrel.

g h is another slender brass pipe, leading from the discharging valve at *g* to the horizontal canal *h k*, to the under side of which it is screwed fast. In this horizontal canal there is a cock *n* which opens a passage from the barrel to the receiver when the key is in the position here drawn; but opens a passage from the barrel to the external air when the key is turned outwards, and from the receiver to the external air when the key is turned inwards. This communication with the external air is not immediate but through a sort of box *i*; the use of this box is to receive the oil which is discharged through the top valve *g*. In order to keep the pump tight, and in working order, it is proper sometimes to pour a table-spoonful of olive-oil into the hole *a* of the pump-plate, and then to work the pump. The oil goes along the conduit *b c d f e*, gets into the barrel and through the piston-valve, when the piston is pressed to the bottom of the barrel, and is then drawn up, and forced through the discharging valve *g* along the pipe *g h*, the horizontal passage *h n*, and finally into the box *i*. This box has a small hole in its side near the top, through which the air escapes.

From the upper side of the canal *c b* there rises a slender pipe which bends outward and then turns downwards, and is joined to a small box, which cannot be seen in this view. From the bottom of this box proceeds downwards the gage-pipe of glass, which enters the cistern of mercury G fixed below.

On the upper side of the other canal at *o* is seen a small stud, having a short pipe of glass projecting horizontally from it, close by and parallel to the front piece of the pump, and reaching to the other canal. This pipe is close at the farther end, and has a small drop of mercury or oil in it at the end *o*. This serves as a gage in condensing, indicating the degree of condensation by the place of the drop: For this drop is forced along the pipe, condensing the air before it in the same degree that it is condensed in the barrel and receiver.

134 Method of joining together different pipes.

In constructing this pump, Mr Smeaton introduced a method of joining together the different pipes and other pieces, which has great advantages over the usual manner of screwing them together with leather between, and which is now much used in hydraulic and pneumatic engines. We shall explain this to our readers by a description of the manner in which the exhausting gage is joined to the horizontal duct *c b*.

Plate CCCCI. Plate CCCCII.

The piece *b i p*, in fig. 22, n° 2. is the same with the little cylinder observable on the upper side of the horizontal canal *c d*, in fig. 23. The upper part *b i* is formed into an outside screw, to fit the hollow screw of the piece *d e e d*. The top of this last piece has a hole in its middle, giving an easy passage to the bent tube *c b a*, so as to slip along it with freedom. To the end *c* of this bent tube is soldered a piece of brass *c f g*, perforated in continuation of the tube, and having its end ground flat on the top of the piece *b i p*, and also covered with a slip of thin leather strained across it and pierced with a hole in the middle.

It is plain from this form, that if the surface *f g* be applied to the top of *h i*, and the cover *d e e d* be screwed down on it, it will draw or press them together, so that no air can escape by the joint, and this without turning the whole tube *c b a* round, as is necessary in the usual way. This method is now adopted for joining together the conducting pipes of the machines for extinguishing fires, an operation which was extremely troublesome before this improvement.

The conduit pipe E *e f c* (fig. 23.) is fastened to the bottom of the barrel, and the discharging pipe *g h* to its top, in the same manner. But to return to the gage; the bent pipe *c b a* enters the box *s t* near one side, and obliquely, and the gage pipe *q r* is inserted through its bottom towards the opposite side. The use of this box is to catch any drops of mercury which may sometimes be dashed up through the gage pipe by an accidental oscillation. This, by going through the passages of the pump, would corrode them, and would act particularly on the joints, which are generally soldered with tin. When this happens to an air-pump, it must be cleaned with the most scrupulous attention, otherwise it will be quickly destroyed.

135 Great power of this pump.

This account of Smeaton's pump is sufficient for enabling the reader to understand its operation and to see its superiority. It is reckoned a very fine pump of the ordinary construction which will rarefy 200 times, or raise the gage to 29.85, the barometer standing at 30. But Mr Smeaton found, that his pump, even after long using, raised it to 29.95, which we consider as equivalent to rarefying 600 times. When in fine order, he found no bounds to its rarefaction, frequently raising the gage as high as the barometer; and he thought its performance so perfect, that the barometer-gage was not sufficiently delicate for measuring the rarefaction. He therefore substituted the syphon gage already described, which he gives some reasons for preferring; but even this he found not sufficiently sensible.

He contrived another, which could be carried to any

any degree of ſenſibility. It conſiſted of a glaſs body A (fig. 24.), of a pear ſhape, and was therefore called the pear-gage. This had a ſmall projecting orifice at B, and at the other end a tube CD, whoſe capacity was the hundredth part of the capacity of the whole veſſel. This was ſuſpended at the ſlip-wire of the receiver, and there was ſet below it a ſmall cup with mercury. When the pump was worked, the air in the pear-gage was rarefied along with the reſt. When the rarefaction was brought to the degree intended, the gage was let down till B reached the bottom of the mercury. The external air being now let in, the mercury was raiſed into the pear, and ſtood at ſome height E in the tube CD. The length of this tube being divided into 100 parts, and thoſe numbered from D, it is evident that $\frac{DE}{DB}$ will expreſs the degree of rarefaction which had been produced when the gage was immerſed into the mercury: or if DC be $\frac{1}{100}$ of the whole capacity, and be divided into 100 parts by a ſcale annexed to it, each unit of the ſcale will be $\frac{1}{10000}$ of the whole.

7 This was a very ingenious contrivance, and has been the means of making ſome very curious and important diſcoveries which at preſent engage the attention of philoſophers. By this gage Mr Smeaton found, that his pump frequently rarefied a thouſand, ten thouſand, nay an hundred thouſand, times. But though he in every inſtance ſaw the great ſuperiority of his pump above all others, he frequently found irregularities which he could not explain, and a want of correſpondence between the pear and the barometer gages which puzzled him. The pear-gage frequently indicated a prodigious rarefaction, when the barometer-gage would not ſhow more than 600.

8 Theſe unaccountable phenomena excited the curioſity of philoſophers, who by this time were making continual uſe of the air-pump in their meteorological reſearches, and much intereſted in every thing connected with the ſtate or conſtitution of elaſtic fluids. Mr Nairne, a moſt ingenious and accurate maker of philoſophical inſtruments, made many curious experiments in the examination and compariſon of Mr Smeaton's pump with thoſe of the uſual conſtruction, attending to every circumſtance which could contribute to the inferiority of the common pumps or to their improvement, ſo as to bring them nearer to this rival machine. This rigorous compariſon brought into view ſeveral circumſtances in the conſtitution of the atmoſpheric air, and its relation to other bodies, which are of the moſt extenſive and important influence in the operations of nature. We ſhall notice at preſent ſuch only as have a relation to the operation of the air-pump in extracting AIR from the receiver.

9 Mr Nairne found, that when a little water, or even a bit of paper damped with water, was expoſed under the receiver of Mr Smeaton's air-pump, when in the moſt perfect condition, raiſing the mercury in the barometer-gage to 29.95, he could not make it riſe above 29.8 if Fahrenheit's thermometer indicated the temperature 47°, nor above 29.7 if the thermometer ſtood at 55°; and that to bring the gage to this height and keep it there, the operation of the pump muſt be continued for a long time after the water had diſappeared or the paper become perfectly dry. He found that a drop of ſpirits, or paper moiſtened with ſpirits, could not in thoſe circumſtances allow the mercury in the gage to riſe to near that height; and that ſimilar effects followed from admitting any volatile body whatever into the receiver or any part of the apparatus. Air-pump.

This ſhowed him at once how improper the directions were which had been given by Gueriche, Boyle, Graveſande, and others, for fitting up the air-pump for experiment, by ſoaking the leather in water, covering the joints with water, or in ſhort, admitting water or any other volatile body near it. 140 Show the impropriety of ſoaking the leather with water,

He therefore took his pumps to pieces, cleared them of all the moiſture which he could drive from them by heat, and then leathered them anew with leather ſoaked in a mixture of olive oil and tallow, from which he had expelled all the water it uſually contains, by boiling it till the firſt frothing was over. When the pumps were fitted up in this manner, he uniformly found that Mr Smeaton's pump rarefied the gage to 29.95, and the beſt common pump to 29.87, the firſt of which he computed to indicate a rarefaction to 600, and the other to 230. But in this ſtate he again found that a piece of damp paper, leather, wood, &c. in the receiver, reduced the performance in the ſame manner as before. 141 And the utility of uſing olive oil and tallow.

But the moſt remarkable phenomenon was, that when he made uſe of the pear-gage with the pump cleared from all moiſture, it indicated the ſame degree of rarefaction with the barometer-gage: but when he expoſed a bit of paper moiſtened with ſpirits, and thus reduced the rarefaction of the pump to what he called 50, the barometer-gage ſtanding at 29.4, the pear-gage indicated a rarefaction exceeding 100,000; in ſhort, it was not meaſurable; and this phenomenon was almoſt conſtant. Whenever he expoſed any ſubſtance ſuſceptible of evaporation, he found the rarefaction indicated by the barometer-gage greatly reduced, while that indicated by the pear-gage was prodigiouſly increaſed; and both theſe effects were more remarkable as the ſubject was of eaſier evaporation, or the temperament of the air of the chamber was warmer. 142 A remarkable phenomenon

This uniform reſult ſuggeſted the true cauſe. Water boils at the temperature 212, that is, it then converted in o a vapour which is permanently elaſtic while of that temperature, and its elaſticity balances the preſſure of the atmoſphere. If this preſſure be diminiſhed by rarefying the air above it, a lower temperature will now allow it to be converted into elaſtic vapour, and keep it in that ſtate. Water will boil in the receiver of an air-pump at the temperament 96, or even under it. Philoſophers did not think of examining the ſtate of the vapour in temperatures lower than what produced ebullition. But it now appears, that in much lower heats than this the ſuperficial water is converted into elaſtic vapour, which continues to exhale from it as long as the water laſts, and, ſupplying the place of air in the receiver, exerts the ſame elaſticity, and hinders the mercury from riſing in the gage in the ſame manner as ſo much air of equal elaſticity would have done. 143 Accounted for.

When Mr Nairne was exhibiting theſe experiments to the Honourable Henry Cavendiſh in 1776, this gentleman informed him that it appeared from a ſeries of experiments of his father Lord Charles Cavendiſh, that when water is of the temperature 72°, it is converted into vapour, under any preſſure leſs than three-fourths of an inch of mercury, and at 41° it becomes vapour when the preſſure is leſs than one-fourth of an inch: 144 Experiments illuſtrating this account.

Even

Air-pump.

Even mercury evaporates in this manner when all pressure is removed. A dewy appearance is frequently observed covering the inside of the tube of a barometer, where we usually suppose a vacuum. This dew, when viewed through a microscope, appears to be a set of detached globules of mercury, and upon inclining the tube so that the mercury may ascend along it, these globules will be all licked up, and the tube become clear. The dew which lined it was the vapour of the mercury condensed by the side of the tube; and it is never observed but when one side is exposed to a stream of cold air from a window, &c.

To return to the vapour in the air-pump receiver, it must be observed, that as long as the water continues to yield it, we may continue to work the pump; and it will be continually abstracted by the barrels, and discharged in the form of water, because it collapses as soon as exposed to the external pressure. All this while the gage will not indicate any more rarefaction, because the thing immediately indicated by the barometer-gage is *diminished elasticity*, which does not happen here. When all the water which the temperature of the room can keep elastic has evaporated under a certain pressure, suppose $\frac{1}{2}$ an inch of mercury, the gage standing at 29.5, the vapour which now fills the receiver expands, and by its diminished elasticity the gage rises, and now some more water which had been attached to bodies by chemical or corpuscular attraction is detached, and a new supply continues to support the gage at a greater height; and this goes on continually till *almost* all has been abstracted: but there will remain some which no art take can away; for as it passes through the barrels, and gets between the piston and the top, it successively collapses into water during the ascent of the piston, and again expands into vapour when we push the piston down again. Whenever this happens there is an end of the rarefaction.

145 Air and vapour not uniformly mixed together.

While this operation is going on, the air comes out along with the vapour; but we cannot say in what proportion. If it were always uniformly mixed with the vapour, it would diminish rapidly; but this does not appear to be the case. There is a certain period of rarefaction in which a transient cloudiness is perceived in the receiver. This is watery vapour formed at that degree of rarefaction, mingled with, but not dissolved in or united with, the air, otherwise it would be transparent. A similar cloud will appear if damp air be admitted suddenly into an exhausted receiver. The vapour, which formed an uniform transparent mass with the air, is either suddenly expanded and thus detached from the other ingredient, or is suddenly let go by the air, which expands more than it does. We cannot affirm with probability which of these is the case: different compositions of air, that is, air loaded with vapours from different substances, exhibit remarkable differences in this respect. But we see from this and other phenomena, which shall be mentioned in their proper places, that the air and vapour are not always intimately united; and therefore will not always be drawn out together by the air-pump. But let them be ever so confusedly blended, we see that the air must come out along with the vapour, and its quantity remaining in the receiver must be prodigiously diminished by this association, probably much more than could be, had the receiver only contained pure air.

146 Confe- ces of differe the p and ba meter gages.

Let us now consider what must happen in the pear-gage. As the air and vapour are continually drawn off from the receiver, the air in the pear expands and goes off with it. We shall suppose that the generated vapour hinders the gage from rising beyond 29.5. During the continued working of the pump, the air in the pear, whose elasticity is 0.5, slowly mixes with the vapour at the mouth of the pear, and the mixture even advances into its inside, so that if the pumping be long enough continued, what is in the pear is nearly of the same composition with what is in the receiver, consisting perhaps of 20 parts of vapour and one part of air, all of the elasticity of 0.5. When the pear is plunged into the mercury, and the external air allowed to get into the receiver, the mercury rises in the pear-gage, and leaves not $\frac{1}{60}$, but $\frac{1}{60 \times 20}$ or $\frac{1}{1200}$ of it filled with common air, the vapour having collapsed into an invisible atom of water. Thus the pear-gage will indicate a rarefaction of 1200, while the barometer-gage only showed 60, that is, showed the elasticity of the included substance diminished 60 times. The conclusion to be drawn from these two measures (the one of the rarefaction of air, and the other of the diminution of elasticity) is, that the matter with which the receiver was filled, immediately before the readmission of the air, consisted of one part of incondensible air, and $\frac{1200}{60}$, or 20 parts of watery vapour.

147 Diffic in acc ing fo some these fequen

The only obscure part of this account is what relates to the composition of the matter which filled the pear-gage before the admission of the mercury. It is not easy to see how the vapour of the receiver comes in by a narrow mouth while the air is coming out by the same passage. Accordingly it requires a *very long time* to produce this extreme rarefaction in the pear-gage; and there are great irregularities in any two succeeding experiments, as may be seen by looking at Mr Nairne's account of them in Philosophical Transactions, Vol. LXVII. Some vapours appear to have mixed much more readily with the air than others; and there are some unaccountable cases where vitriolic acid and sulphureous bodies were included, in which the diminution of density indicated by the pear-gage was uniformly less than the diminution of elasticity indicated by the barometer-gage. It is enough for us at present to have established, by unquestionable facts, this production of elastic vapour, and the necessity of attending to it, both in the construction of the air-pump and in drawing results from experiments exhibited in it.

148 The su riority this p excites new i prove ments

Mr Smeaton's pump, when in good order, and perfectly free from all moisture, will in dry weather rarefy air about 600 times, raising the barometer-gage to within $\frac{1}{20}$ of an inch of a fine barometer. This was a performance so much superior to that of all others, and by means of Mr Nairne's experiments opened so new a field of observation, that the air-pump once more became a capital instrument among the experimental philosophers. The causes of its superiority were also so distinct, that artists were immediately excited to a farther improvement of the machine; so that this becomes a new epoch in its history.

This is one imperfection which Mr Smeaton has not attempted to remove. The discharging valve is still open-ed

ed againſt the preſſure of the atmoſphere. An author of the Swediſh academy adds a ſubſidiary pump to this valve, which exhauſts the air from above it, and thus puts it in the ſituation of the piſton valve. We do not find that this improvement has been adopted ſo as to become general. Indeed the quantity of air which remains in the paſſage to this valve is ſo exceedingly little, that it does not ſeem to merit attention. Suppoſing the valve-hole $\frac{1}{20}$ of an inch wide and as deep (and it need not be more), it will not occupy more than $\frac{1}{9600}$ part of a barrel twelve inches long and two inches wide.

Mr Smeaton, by his ingenious conſtruction, has greatly diminiſhed, but has not annihilated, the obſtructions to the paſſage of the air from the receiver into the barrel. His ſucceſs encouraged farther attempts. One of the firſt and moſt ingenious was that of Profeſſor Ruſſel of the univerſity of Edinburgh, who about the year 1770 conſtructed a pump in which both cocks and valves were avoided.

The piſton is ſolid, as repreſented in fig. 25. and its rod paſſes through a collar of leather on the top of the barrel. This collar is divided into three portions by two braſs rings *a*, *b*, which leave a very ſmall ſpace round the piſton rod. The upper ring *a* communicates by means of a lateral perforation with the bent tube *l m n*, which enters the barrel at its middle *n*. The lower ring *b* communicates with the bent tube *c d*, which communicates with the horizontal paſſage *d e*, going to the middle *e* of the pump plate. By the way, however, it communicates alſo with a barometer gage *p o*, ſtanding in a ciſtern of mercury *o*, and covered with a glaſs tube cloſe at the top. Beyond *e*, on the oppoſite circumference of the receiver plate, there is a cock or plug *f* communicating with the atmoſphere.

The piſton rod is cloſely embraced by the three collars of leather; but, as already ſaid, has a free ſpace round it in the two braſs rings. To produce this preſſure of the leathers to the rod, the braſs rings which ſeparate them are turned thinner on the inner ſide, ſo that their croſs ſection along a diameter would be a taper wedge. In the ſide of the piſton rod are two cavities *q r*, *t s*, about one-tenth of an inch wide and deep, and of a length equal to the thickneſs of the two rings *a*, *b*, and the intermediate collar of leathers. Theſe cavities are ſo placed on the piſton-rod, that when the piſton is applied to the bottom of the barrel, the cavity *t s* in the upper end of the rod has its upper end oppoſite to the ring *a*, and its lower end oppoſite to the ring *b*, or to the mouth of the pipe *c d*. Therefore, if there be a void in the barrel, the air from the receiver will come from the pipe *c d* into the cavity in the piſton rod, and by it will get paſt the collar of leather between the rings, and thus will get into the ſmall interſtice between the rod and the upper ring, and then into the pipe *l m n*, and into the empty barrel. When the piſton is drawn up, the ſolid rod immediately ſhuts up this paſſage, and the piſton drives the air through the diſcharging valve *k*. When it has reached the top of the barrel, and is cloſely applied to it, the cavity *q r* is in the ſituation in which *t s* formerly was, and the communication is again opened between the receiver and the empty barrel, and the air is again diffuſed between them. Puſhing down the piſton expels the air by the lower diſcharging pipe and valve *b i*; and thus the operation may be continued.

This muſt be acknowledged to be a moſt ſimple and ingenious conſtruction, and can neither be called a cock nor a valve. It ſeems to oppoſe no obſtruction whatever: and it has the ſuperior advantage of rarefying both during the aſcent and the deſcent of the piſton, doubling the expedition of the performance, and the operator is not oppoſed by the preſſure of the atmoſphere except towards the end of each ſtroke. The expedition, however, is not ſo great as one ſhould expect; for nothing is going on while the piſton is in motion, and the operator muſt ſtop a while at the end of each ſtroke, that the air may have time to come through this long, narrow, and crooked paſſage, to fill the barrel. But the chief difficulty which occurred in the execution aroſe from the clammy oil with which it was neceſſary to impregnate the collar of leathers. Theſe were always in a ſtate of ſtrong compreſſion, that they might cloſely graſp the piſton rod, and prevent all paſſage of air during the motion of the piſton. Whenever therefore the cavities in the piſton rod come into the ſituations neceſſary for connecting the receiver and barrel, this oil is ſqueezed into them, and choaks them up. Hence it always happened that it was ſome time after the ſtroke before the air could force its way round the piſton rod, carrying with it the clammy oil which choaked up the tube *l m n*; and when the rarefaction had proceeded a certain length, the diminiſhed elaſticity of the air was not able to make its way through theſe obſtructions. The death of the ingenious author put a ſtop to the improvements by which he hoped to remedy this defect, and we have not heard that any other perſon has ſince attempted it. We have inſerted it here, becauſe its principle of conſtruction is not only very ingenious, but entirely different from all others, and may furniſh very uſeful hints to thoſe who are much engaged in the conſtruction of pneumatic engines.

Air-pump.

152 By Haas and Hurter,

In the 73d volume of the Philoſophical Tranſactions, Mr Tiberius Cavallo has given the deſcription of an air-pump contrived and executed by Meſſrs Haas and Hurter, inſtrument-makers in London, where theſe artiſts have revived Guericke's method of opening the barrel-valve during the laſt ſtrokes of the pump by a force acting from without. We ſhall inſert ſo much of this deſcription as relates to this diſtinguiſhing circumſtance of its conſtruction.

Fig. 26. repreſents a ſection of the bottom of the barrel, where AA is the barrel and BB the bottom, which has in its middle a hollow cylinder CCFF, projecting about half an inch into the barrel at CC, and extending a good way downwards to FF. The ſpace between this projection and the ſides of the barrel is filled up by a braſs ring DD, over the top of which is ſtrained a piece of oiled ſilk EE, which performs the office of a valve, covering the hole CC. But this hole is filled up by a piece of braſs, or rather an aſſemblage of pieces ſcrewed together GGHHII. It conſiſts of three projecting fillets or ſhoulders GG, HH, II, which form two hollows between them, and which are filled with rings of oiled leather OO, PP, firmly ſcrewed together. The extreme fillets GG, II, are of equal diameter with the inſide of the cylinder, ſo as to fill it exactly, and the whole ſtuffed with oiled leather, ſlide up and down without allowing any air to paſs. The middle fillet HH is not ſo broad, but thicker. In the upper fillet GG there is formed a ſhallow diſh about $\frac{1}{8}$ of an inch deep

Air-pump. deep and $\frac{3}{4}$ wide. This diſh is covered with a thin plate, pierced with a grating like Mr Smeaton's valve-plate. There is a perforation VX along the axis of this piece, which has a paſſage out at one ſide H, through the middle fillet. Oppoſite to this paſſage, and in the ſide of the cylinder CCFF, is a hole M, communicating with the conduit pipe MN, which leads to the receiver. Into the lower end of the perforation is ſcrewed the pin KL, whoſe tail L paſſes through the cap FF. The tail L is connected with a lever RQ, moveable round the joint Q. This lever is puſhed upwards by a ſpring, and thus the whole piece which we have been deſcribing is kept in contact with the ſlip of oiled ſilk or valve EE. This is the uſual ſituation of things.

153 Now ſuppoſe a void formed in the barrel by drawing up the piſton; the elaſticity of the air in the receiver, in the pipe NM, and in the paſſage XV, will preſs on the great ſurface of the valve expoſed through the grating, will raiſe it, and the pump will perform preciſely as Mr Smeaton's does. But ſuppoſe the rarefaction to have been ſo long continued, that the air is no longer able to raiſe the valve; this will be ſeen by the mercury riſing no more in the pump-gage. When this is perceived, the operator muſt preſs with his foot on the end R of the lever RQ. This draws down the pin KL, and with it the whole hollow plug with its grated top. And thus, inſtead of raiſing the valve from its plate, the plate is here drawn down from the valve. The air now gets in without any obſtruction whatever, and the rarefaction proceeds as long as the piſton riſes. When it is at the top of the barrel, the operator takes his foot from the lever, and the ſpring preſſes up the plug again and ſhuts the valve. The piſton rod paſſes through a collar of leather, as in Mr Smeaton's pump, and the air is finally diſcharged through an outward valve in the top of the barrel. Theſe parts have nothing peculiar in them.

This is an ingenious contrivance, ſimilar to what was adapted by Guericke himſelf; and we have no doubt of theſe pumps performing extremely well if carefully made; and it ſeems not difficult to keep the plug perfectly air-tight by ſupplying plenty of oil to the leathers. We cannot ſay, however, with preciſion what may be expected from it, as no account has been given of its effects beſides what Mr Cavallo publiſhed in Philoſophical Tranſactions 1783, where he only ſays, that when it had been long uſed, it had, in the courſe of ſome experiments, rarefied 600 times.

154 By Prince, Aiming ſtill at the removing the obſtructions to the entry of the air from the receiver into the barrels, Mr Prince, an American, has conſtructed a pump in which there is no valve or cock whatever between them. In this pump the piſton rod paſſes through a collar of leathers, and the air is finally diſcharged through a valve, as in the two laſt. But we are chiefly to attend, in this place, to the communication between the barrel and the receiver. The barrel widens below into a ſort of ciſtern ABCD (fig. 27.), communicating with the receiver by the pipe EF. As ſoon, therefore, as the piſton gets into this wider part, where there is a vacancy all round it, the air of the receiver expands freely through the paſſage FEE into the barrel, in which the deſcent of the piſton had made a void. When the piſton is again drawn up, as ſoon as it gets into the cylindric part of the barrel, which it exactly fills, it carries up the air before it, and expels it by the top valve; and, that this may be done more completely, this valve opens into a ſecond barrel or air-pump whoſe piſton is riſing at the ſame time, and therefore the valve of communication (which is the diſcharging valve of the primary pump) opens with the ſame facility as Mr Smeaton's piſton valve. While the piſton is riſing, the air in the receiver expands into the barrel; and when the piſton deſcends, the air in the barrel again collapſes till the piſton gets again into the ciſtern, when the air paſſes out, and fills the evacuated barrel, to be expelled by the piſton as before.

Plate CCCCII.

No diſtinct account has as yet been given of the performance of this pump. We only learn that great inconveniences were experienced from the oſcillations of the mercury in the gage. As ſoon as the piſton comes into the ciſtern, the air from the receiver immediately ruſhes into the barrel, and the mercury ſhoots up in the gage, and gets into a ſtate of oſcillation. The ſubſequent riſe of the piſton will frequently keep time with the ſecond oſcillation, and increaſe it. The deſcent of the piſton produces a downward oſcillation, by allowing the air below it to collapſe; and, by improperly timing the ſtrokes, this oſcillation becomes ſo great as to make the mercury enter the pump. To prevent this, and a greater irregularity of working as a condenſer, valves were put in the piſton: but as theſe require force to open them, the addition ſeemed rather to increaſe the evil, by rendering the oſcillations more ſimultaneous with the ordinary rate of working. If this could be got over, the conſtruction ſeems very promiſing.

It appears, however, of very difficult execution. It has many long, ſlender, and crooked paſſages, which muſt be drilled through broad plates of braſs, ſome of them appearing ſcarcely practicable. It is rare to find plates and other pieces of braſs without air-holes, which it would be very difficult to find out and to cloſe; and it muſt be very difficult to clear it of obſtructions: ſo that it appears rather a ſuggeſtion of theory than a thing warranted by its actual performance.

Mr Lavoiſier, or ſome of the naturaliſts who were occupied in concert with him in the inveſtigation of the different ſpecies of gas which are diſengaged from bodies in the courſe of chemical operations, has contrived an air-pump which has great appearance of ſimplicity, and, being very different from all others, deſerves to be taken notice of. 155 By Lavoiſier,

It conſiſts of two barrels *l*, *m*, fig. 28. with ſolid piſtons *k k*. The pump-plate *a b* is pierced at its centre *c* with a hole which branches towards each of the barrels, as repreſented by *c d*, *c e*. Between the plate and the barrels ſlides another plate *h i*, pierced in the middle with a branched hole *f d g*, and near the ends with two holes *h h*, *i i*, which go from its underſide to the ends. The holes in theſe two plates are ſo adjuſted, that when the plate *h i* is drawn ſo far towards *h* that the hole *i* comes within the barrel *m*, the branch *d f* of the hole in the middle plate coincides with the branch *c d* of the upper plate, and the holes *e*, *g* are ſhut. Thus a communication is eſtabliſhed between the barrel *l* and the receiver on the pump-plate, and between the barrel *m* and the external air. In this ſituation the barrel *l* will exhauſt, and *m* will diſcharge. When the piſton of *l* is at its mouth, and that of *m* touches its bottom, the ſliding plate is ſhifted over to the other ſide, ſo that

m com-

Air-pump. *m* communicates with the receiver through the paffage *gd*, *ec*, and *l* communicates with the air by the paffages *h h*.

It is evident that this fliding plate performs the office of four cocks in a very beautiful and fimple manner, and that if the piftons apply clofe to the ends of the barrels, fo as to expel the whole air, the pump will be perfect. It works, indeed, againft the whole preffure of the external air. But this may be avoided by putting valves on the holes *h*, *i*; and thefe can do no harm, becaufe the air remaining in them never gets back into the barrel till the pifton be at the farther end, and the exhauftion of that ftroke completed. But the beft workmen of London think that it will be incomparably more difficult to execute this cock (for it is a cock of an unufual form), in fuch a manner that it fhall be air-tight and yet move with tolerable eafe, and that it is much more liable to wearing loofe than common cocks. No accurate accounts have been received of its performance. It muft be acknowledged to be ingenious, and it may fuggeft to an intelligent artift a method of combining common conical cocks upon one axis fo as to anfwer the fame purpofes much more effectually; for which reafon we have inferted it here.

156 ... by ... ert- The laft improvement which we fhall mention is that publifhed by Mr Cuthbertfon philofophical inftrument-maker in Amfterdam. His pump has given fuch evidences of its perfection, that we can hardly expect or wifh for any thing more complete. But we muft be allowed to obferve, beforehand, that the fame conftruction was invented, and, in part, executed before the end of 1779, by Dr Daniel Rutherford, now profeffor of botany in the univerfity of Edinburgh, who was at that time engaged in experiments on the production of air during the combuftion of bodies in contact with nitre, and who was vaftly defirous of procuring a more complete abftraction of pure aerial matter than could be effected by Mr Smeaton's pump. The compiler of this article had then an opportunity of perufing the Doctor's differtation on this fubject, which was read in the Philofophical Society of Edinburgh. In this differtation the Doctor appears fully apprifed of the exiftence of pure vital air in the nitrous acid as its chief ingredient, and as the caufe of its moft remarkable phenomena, and to want but a ftep to the difcoveries which have ennobled the name of Mr Lavoifier. He was particularly anxious to obtain *apart* this diftinguifhing ingredient in its compofition, and, for this purpofe, to abftract completely from the veffel in which he fubjected it to examination, every particle of elaftic matter. The writer of this article propofed to him to cover the bottom of Mr Smeaton's pifton with fome clammy matter, which fhould take hold of the bottom valve, and *ftart it* when the pifton was drawn up. A few days after, the Doctor fhowed him a drawing of a pump, having a conical metal valve in the bottom, furnifhed with a long flender wire, fliding in the infide of the pifton-rod with a gentle friction, fufficient for lifting the valve, and fecured againft all chance of failure by a fpring a-top, which took hold of a notch in the infide of the pifton-rod about a quarter of an inch from the lower end, fo as certainly to lift the valve during the laft quarter of an inch of the pifton's motion. Being an excellent mechanic, he had executed a valve on this principle, and was fully fatisfied with its performance. But having already confirmed his doctrines refpecting the nitrous acid by incontrovertible experiments, his wifhes to improve the air-pump loft their incitement, and he thought no more of it; and not long after this, the ardour of the philofophers of the Teylerian Society at Haerlem and Amfterdam excited the efforts of Mr Cuthbertfon, their inftrument-maker, to the fame purpofe, and produced the moft perfect air-pump that has yet appeared. We fhall give a defcription of it, and an account of its performance, in the inventor's own words.

Cuthbertson's Air-Pump.

Plate CCCCVIII. is a perfpective view of this pump, with its two principal gages fcrewed into their places. Thefe need not be ufed together, except in cafes where the utmoft exactnefs is required. In common experiments one of them is removed, and a ftop-fcrew put in its place. When the pear-gage is ufed, a fmall round plate, on which the receiver may ftand, muft be firft fcrewed into the hole at A; but this hole is ftopped on other occafions with a fcrew. When all the three gages are ufed, and the receiver is exhaufted, the ftop-fcrew B, at the bottom of the pump, muft be unfcrewed, to admit the air into the receiver; but when they are not all ufed, either of the other ftop-fcrews will anfwer this purpofe. 157

Fig. 2. reprefents a crofs-bar for preventing the barrels from being fhaken by working the pump or by any accident. Its place in fig. 1. is reprefented by the dotted lines. It is confined in its place, and kept clofe down on the barrels by two flips of wood NN, which muft be drawn out, as well as the fcrews OO, when the pump is to be taken afunder.

Plate CCCCIX. is a fection of all the working parts of the pump, except the wheel and rack, in which there is nothing uncommon.

Fig. 1. is a fection of one of the barrels, with all its internal parts; and fig. 2, 3, 4, and 5, are different parts of the pifton, proportioned to the fize of the barrel (A) and to one another.

In fig. 1. CD reprefents the barrel, F the collar of leathers, G a hollow cylindrical veffel to contain oil, R is alfo an oil-veffel to receive the oil which is drawn, along with the air, through the hole *a a*, when the pifton is drawn upwards; and, when this is full, the oil is carried over with the air, along the tube T, into the oil-veffel G. *c c* is a wire which is driven upwards from the hole *a a* by the paffage of the air; and as foon as this has efcaped, it falls down again by its own weight, fhuts up the hole, and prevents all return of the air into the barrel. At *d d* are fixed two pieces of brafs, to keep the wire *c c* in a vertical direction, that it may accurately fhut the hole. H is a cylindrical

O 2

(A) The pifton and barrel are 1,65 inches in diameter, in proportion to which the fcale is drawn. Figures 2, 3, 4, 5. are, however, of double fize.

Air-pump.

cal wire or rod which carries the piston I, and is made hollow to receive a long wire gg, which opens and shuts the hole L; and on the other end of the wire O is screwed a nut, which, by stopping in the narrowest part of the hole, prevents the wire from being driven up too far. This wire and screw are more clearly seen in fig. 2. and 6; they slide in a collar of leather rr, fig. 2. and 5. in the middle piece of the piston. Fig. 4. and 5. are the two mean parts which compose the piston, and, when the pieces 3. and 6. are added to it, the whole is represented by fig. 2. Fig. 5. is a piece of brass of a conical form, with a shoulder at the bottom. A long hollow screw is cut in it, about $\frac{1}{7}$ of its length, and the remainder of the hole, in which there is no screw, is of about the same diameter with the screwed part, except a thin plate at the end, which is of a width exactly equal to the thickness of gg. That part of the inside of the conical brass in which no thread is cut, is filled with oiled leathers with holes through which gg can slide stiffly. There is also a male screw with a hole in it, fitted to gg, serving to compress the leathers rr. In fig. 4. $aaaa$ is the outside of the piston, the inside of which is turned so as exactly to fit the outside of fig. 5. bb are round leathers about 60 in number, cc is a circular piece of brass of the size of the leathers, and dd is a screw serving to compress them. The screw at the end of fig. 3. is made to fit the screw in fig. 5. Now if fig. 6. be pushed into fig. 5, this into fig. 4, and fig. 3. be screwed into the end of fig. 5, these will compose the whole of the piston, as represented in fig. 2. H in fig. 1. represents the same part as H in fig. 2, and is that to which the rack is fixed. If, therefore, this be drawn upwards, it will cause fig. 5. to shut close into fig. 4, and drive out the air above it; and when it is pushed downward, it will open as far as the shoulder aa will permit, and suffer air to pass through. AA fig. 7. is the receiver plate, BB is a long square piece of brass, screwed into the under side of the plate, through which a hole is drilled corresponding to that in the centre of the receiver-plates and with three female screws b, b, c.

Plate CCCCIX.

The rarefaction of the air in the receiver is effected as follows. Suppose the piston at the bottom of the barrel. The inside of the barrel, from the top of the piston to a, contains common air. When the rod is drawn up, the upper part of the piston sticks fast in the barrel till the conical part connected with the rod shuts the conical hole, and its shoulder applies close to its bottom. The piston is now shut, and therefore the *whole* is drawn up by the rack-work, driving the air before it through the hole aa, into the oil-vessel at R, and out into the room by the tube T. The piston will then be at the top of the barrel at a, and the wire gg will stand nearly as represented in the figure just raised from the hole L, and prevented from rising higher by the nut O. During this motion the air will expand in the receiver, and come along the bent tube m into the barrel. Thus the barrel will be filled with air, which, as the piston rises, will be rarefied in proportion as the capacity of the receiver, pipes, and barrel is to the barrel alone. When the piston is moved down again by the rack-work, it will force the conical part fig. 5. out of the hollow part fig. 4. as far as the shoulders aa; fig. 2. will rest on aa fig. 4, which will then be so far open as to permit the air to pass freely through it, while at the same time the end of gg is forced against the top of the hole, and shuts it in order to prevent any air from returning into the receiver. Thus the piston, moving downwards, suffers the air to pass out between the sides of fig. 4. and 5.; and, when it is at the bottom of the barrel, will have the column of air above it; and, consequently, when drawn upwards it will shut, and drive out this air, and, by opening the hole L at the same time, will give a free passage to more air from the receiver. This process being continued, the air of the receiver will be rarefied *as far as its expansive power will permit*. For in this machine there are no valves to be forced open by the elasticity of the air in the receiver, which at last it is unable to effect. There is therefore nothing to prevent the air from expanding to its utmost degree.

It may be suspected here, that as the air must escape thro' the discharging passage ac, Plate CCCCIX. fig. 1. against the pressure of a column of oil and the weight of the wire, there will remain in this passage a quantity of air of considerable density, which will expand again into the barrel during the descent of the piston, and thus put a stop to the progress of rarefaction. This is the case in Mr Smeaton's pump, and all which have valves in the piston. But it is the peculiar excellency of this pump, that whatever be the density of the air remaining in ac, the rarefaction will still go on. It is worth while to be perfectly convinced of this. Let us suppose that the air contained in ac is $\frac{1}{100}$ part of the common air which would fill the barrel, and that the capacity of the barrel is equal to that of the receiver and passages, and that the air in the receiver and barrel is of the same density, the piston being at the bottom of the barrel: The barrel will therefore contain $\frac{10}{1000}$ parts of its natural quantity, and the receiver $\frac{10}{1000}$. Now let the piston be drawn up. No air will be discharged at ac, because it will contain the whole air which was in the barrel, and which has now collapsed into its ordinary bulk. But this does not in the least hinder the air of the receiver from expanding into the barrel, and diffusing itself equally between both. Each will now contain $\frac{5}{1000}$ of their ordinary quantity when the piston is at the top, and ac will contain $\frac{1}{100}$ as before, or $\frac{10}{1000}$. Now push down the piston. The hole L is instantly shut, and the air in ac expands into the barrel, and the barrel now contains $\frac{15}{1000}$. When the piston has reached the bottom, let it be again drawn up. There will be $\frac{5}{1000}$ discharged through c, and the air in the receiver will again be equally distributed between it and the barrel. Therefore the receiver will now contain $\frac{2\frac{1}{2}}{1000}$. When the piston reaches the bottom, there will be $\frac{12\frac{1}{2}}{1000}$ in the barrel. When again drawn up to the top, there will be $\frac{2\frac{1}{2}}{1000}$ discharged, and the receiver will contain $\frac{1\frac{1}{4}}{1000}$; and when the piston reaches the bottom, there will be $\frac{11\frac{1}{4}}{1000}$. At the next stroke the receiver will contain only $\frac{0.\frac{5}{8}}{1000}$, &c. &c.

Thus it appears, that notwithstanding the $\frac{10}{1000}$ which always

Air-pump. always expands back again out of the hole ac into the barrel, the rarity of the air in the receiver will be doubled at every stroke. There is therefore no need of a subsidiary air-pump at c, as in the American air-pump, and in the Swedish attempt to improve Smeaton's.

In using this air-pump no particular directions are necessary, nor is any peculiar care necessary for keeping it in order, except that the oil-vessel A be always kept about half full of oil. When the pump has stood long without being used, it will be proper to draw a table-spoonful of olive-oil through it, by pouring it into the hole in the middle of the receiver-plate when the piston is at the bottom of the barrel. Then by working the piston, the oil will be drawn through all the parts of the pump, and the surplus will be driven through the tube T into the oil-vessel G. Near the top of the piston-rod at H there is a hole which lets some oil into the inside of the rod, which gets at the collar of leathers $r\,r$, and keeps the wire $g\,g$ air-tight.

When the pump is used for condensation at the same time that it rarefies, or separately, the piece containing the bent tube T must be removed, and fig. 8. put Plate CCCCIX. into its place, and fixed by its screws. Fig. 8. as drawn in the plate, is intended for a double barreled pump. But for a single barrel only one piece is used, represented by $b\,a\,a$, the double piece being cut off at the dotted line $a\,a$. In this piece is a female screw to receive the end of a long brass tube, to which a bladder (if sufficient for the experiment of condensation), or a glass, properly secured for this purpose, must be screwed. Then the air which is abstracted from the receiver on the pump-plate will be forced into the bladder or glass. But if the pump be double, the apparatus fig. 8. is used, and the long brass tube screwed on at c.

Fig. 9. and 10. represent the two gages, which will be sufficiently explained afterwards. Fig. 9. is screwed into $c\,b$, or into the screw at the other end of c fig. 7. and fig. 10. into the screw $a\,b$ fig. 7.

If it be used as a single pump, either to rarefy or condense, the screw K, which fastens the rack to the piston-rod H, must be taken out. Then turning the winch till H is depressed as low as possible, the machine will be fitted to exhaust as a single pump; and if it be required to condense, the direction in n° 8. must be observed with regard to the tube T, and fig. 8.

"I took (says Mr Cuthbertson) two barometer-tubes of an equal bore with that fixed to the pump. These were filled with mercury four times boiled. They were then compared, and stood exactly at the same height. The mercury in one of them was boiled in it four times more, without making any change in their height; they were therefore judged very perfect. One of these was immersed in the cistern of the pump-gage, and fastened in a position parallel to it, and a sliding scale of one inch was attached to it. This scale, when the gage is used, must have its upper edge set equal with the surface of the mercury in the boiled tube after exhaustion, and the difference between the height of the mercury in this and in the other barometer tube may be observed to the $\frac{1}{100}$ of an inch; and being close together, no error arises from their not being exactly vertical, if they are only parallel. This gage will be better understood by inspecting fig. 10.

"I used a second gage, which I shall call a double syphon. See Plate CCCCIX. fig. 9. This was also prepared with the utmost care. I had a scale for measuring the difference between the height of the columns in the two legs. It was an inch long, and divided as the former, and kept in a truly vertical position by suspending it from a point with a weight hung to it, as represented in the figure. Upon comparing these two gages, I always found them to indicate the same degree of rarefaction. I also used a pear-gage, though the most imperfect of all, in order to repeat the curious experiments of Mr Nairne and others."

When experiments require the utmost rarefying power of the pump, the receiver must not be placed on leather, either oiled or soaked in water, as is usually done. The pump-plate and the edge of the receiver must be ground very flat and true, and this with very fine emery, that no roughness may remain. The plate of the pump must then be wiped very clean and very dry, and the receiver rubbed with a warm cloth till it become electrical. The receiver being now set on the plate, hog's lard, either alone or mixed with a little oil, which has been cleared of water by boiling, must be smeared round its outside edge. In this condition the pump will rarefy its utmost, and what still remains in the receiver will be permanent air. Or a little of this composition may be thinly smeared on the pump-plate; this will prevent all risk of scratching it with the edge of the receiver. Leather of very uniform thickness, long dried before a fire, and well soaked in this composition, which must be cleared of all water by the first boiling, will answer very well, and is expeditious, when receivers are to be frequently shifted. Other leathers should be at hand soaked in a composition containing a little rosin. This gives it a clamminess which renders it impermeable to air, and is very proper at all joints of the pump, and all apparatus for pneumatic experiments. As it is impossible to render the pear-gage as dry as other parts of the apparatus, there will be generally some variation between this and the other gages.

When it is only intended to show the utmost power of the pump, without intending to ascertain the quality of the residuum, the receiver may be set on wet leather. If, in this condition, the air be rarefied as far as possible, the syphon and barometer gage will indicate a less degree of rarefaction than in the former experiments. But when the air is let in again, the pear-gage will point out a rarefaction some thousands of times greater than it did before. If the true quality of permanent air after exhaustion be required, the pear-gage will be nearest the truth: for when the air is rarefied to a certain degree, the moistened leather emits an expansible fluid, which, filling the receiver, forces out the permanent air; and the two first gages indicate a degree of exhaustion which relates to the whole elastic matter remaining in the receiver, *viz.* to the expansible fluid together with the permanent air; whereas the pear-gage points out the degree of exhaustion, with relation to the permanent air alone, which remains in the receiver; for by the pressure of the air admitted into the receiver, the elastic vapour is reduced to its former bulk, which is imperceptible.

Many bodies emit this elastic fluid when the pressure of the air is much diminished; a piece of leather, in its ordinary

Air-pump. ordinary damp ftate, about an inch fquare, or a bit of green or dry wood, will fupply this for a great while.

When fuch fluids have been generated in any experiments, the pump muft be carefully cleared of them, for they remain not only in the receiver, but in the barrels and paffages, and will again expand when the exhauftion has been carried far.

The beft method of clearing the pump is to take a very large receiver, and, ufing every precaution to exhauft it as far as poffible. Then the expanfible matter lurking in the barrels and paffes will be diffufed through the receiver alfo, or will be carried off along with its air. It will be as much rarer than it was before, as the aggregate capacity of the receiver barrels and paffes is larger than that of the two laft.

The performance of the pump may be judged of from the four following experiments.

The two gages being fcrewed into their places, and the hole in the receiver-plate fhut up, the pump was made to exhauft as far as it could. The mercury in the legs of the fyphon was only $\frac{1}{40}$ of an inch out of the level, and that in the boiled barometer-tube $\frac{1}{40}$ of an inch higher than in the one fcrewed to the pump. A ftandard barometer then ftood at 30 inches, and therefore the pump rarefied the permanent air 1200 times. This is twice as much as Mr Nairne found Mr Smeaton's do in its beft ftate. Mr Cavallo feems difpofed to give a favourable (while we muft fuppofe it a juft) account of Haas and Hurter's pump, and it appears never to have exceeded 600 times. Mr Cuthbertfon has often found the mercury within $\frac{1}{100}$ of an inch of the level in the fyphon-gage, indicating a rarefaction of 3000.

To one end of a glafs tube, 2 inches diameter and 30 inches long, was fitted a brafs cap and collar of leather, through which a wire was inferted, reaching about two inches within the tube. This was connected with the conductor of an electric machine. The other end was ground flat and fet on the pump plate. When the gages indicated a rarefaction of 300, the light became fteady and uniform, of a pale colour, though a little tinged with purple; at 600 the light was of a pale dufky white; when 1200 it difappeared in the middle of the tube, and the tube conducted fo well that the prime conductor only gave fparks fo faint and fhort as to be fcarcely perceptible. After taking off the tube, and making it as dry as poffible, it was again connected with the conductor, which was giving fparks two inches long. When the air in it was rarefied ten times, the fparks were of the fame length. Sometimes a pencil of light darted along the tube. When the rarefaction was 20, the fpark did not exceed an inch, and light ftreamed the whole length of the tube. When the rarefaction was 30, the fparks were half an inch, and the light rufhed along the tube in great ftreams. When the rarefaction was 100, the fparks were about $\frac{1}{8}$ long, and the light filled the tube in an uninterrupted body. When 300, the appearances were as before. When 600, the fparks were $\frac{1}{10}$, and the light was of a faint white colour in the middle, but tinged with purple toward the ends. When 1200, the light was hardly perceptible in the middle, and was much fainter at the ends than before, but ftill ruddy. When 1400, which was the moft the pump could produce, fix inches of the middle of the tube were quite dark, and the ends free of any tinge of red, and the fparks did not exceed $\frac{1}{40}$ of an inch.

158 The beft improvements of the air-pump have been made in Britain.

We truft that our readers will not be difpleafed with the preceding hiftory of the air-pump. The occafional information which it gives will be of great ufe to every perfon much engaged in pneumatic experiments, and help him in the contrivance and conftruction of the neceffary apparatus.

We may be indulged in one remark, that although this noble inftrument originated in Germany, all its improvements were made in this kingdom. Both the mechanical and pneumatical principles of Mr Boyle's conftruction were extremely different from the German, and, in refpect of expedition and conveniency, much fuperior. The double barrel and gage by Hawkefbee were capital improvements, and on principle; and Mr Smeaton's method of making the pifton work in rarefied air made a complete change in the whole procefs.

159 Utility of the air-pump.

Aided by this machine, we can make experiments eftablifhing and illuftrating the gravity and elafticity of the air in a much more perfpicuous manner than could be done by the fpontaneous phenomena of nature.

160 Experiments to fhow this utility.

It allows us in the firft place to fhow the materiality of air in a very diftinct manner. Bodies cannot move about in the atmofphere without difplacing it. This requires force; and the refiftance of the air always diminifhes the velocity of bodies moving in it. A heavy body therefore has the velocity of its fall diminifhed; and if the quantity of air difplaced be very great, the diminution will be very confiderable. This is the reafon why light bodies, fuch as feathers, fall very flowly. Their moving force is very fmall, and can therefore difplace a great quantity of air only with a very fmall velocity. But if the fame body be dropped *in vacuo*, when there is no air to be difplaced, it falls with the whole velocity competent to its gravity. Fig. 29. Plate CCCCII. reprefents an apparatus by which a guinea and a downy feather are dropped at the fame inftant, by opening the forceps which holds them by means of the flip-wire in the top of the receiver. If this be done after the air has been pumped out, the guinea and the feather will be obferved to reach the bottom at the fame inftant.

161 Fig. 30. reprefents another apparatus for fhowing the fame thing. It confifts of two fets of brafs vanes put in feparate axles, in the manner of windmill-fails. One fet has their edges placed in the direction of their whirling motion, that is, in a plane to which the axis is perpendicular. The planes of the other fet pafs through the axis, and they are therefore trimmed fo as directly to front the air through which they move. Two fprings act upon pins projecting from the axis; and their ftrength or tenfions are fo adjufted, that when they are difengaged *in vacuo*, the two fets continue in motion equally long. If they are difengaged in the air, the vanes which beat the air with their planes will ftop long before thofe which cut it edgewife.

162 We can now abftract the air almoft completely from a dry veffel, fo as to know the precife weight of the air which filled it. The firft experiment we have of this kind, done with accuracy, is that of Dr Hooke, Feb. 10. 1664, when he found 114 pints of air to

weigh

ump. weigh 945 grains. One pint of water was $8\frac{7}{12}$ ounces. This gives for the specific gravity of air $\frac{1}{850}$ very nearly.

63 effect on weight dies ersed Since we are thus immersed in a gravitating fluid, it follows, that every body preponderates only with the excess of its own weight above that of the air which it displaces; for every body loses by this immersion the weight of the displaced air. A cubic foot loses about 521 grains in frosty weather. We see balloons even rise in the air, as a piece of cork rises in water. A mass of water which really contains 850 pounds will load the scale of a balance with 849 only, and will be balanced by about $849\frac{1}{5}$ pounds of brass. This is evinced by a very pretty experiment, represented in fig. 31. A small beam is suspended within a receiver. To one end of the beam is appended a thin glass or copper ball, close in every part. This is balanced by a small piece of lead hung on the other arm. As the air is pumped out of the receiver, the ball will gradually preponderate, and will regain its equilibrium when the air is re-admitted.

late CCII.

64 Some naturalists have proposed, and actually used, a large globe of light make, suspended at a beam, for a barometer. If its capacity is a cubic foot, $1\frac{7}{10}$ grains will indicate the same change that is indicated by $\frac{1}{10}$ of an inch of an ordinary barometer. But a vessel of this size will load a balance too much to leave it sufficiently sensible to small changes of density. Besides, it is affected by heat and cold, and would require a very troublesome equation to correct their effects.

165 It may perhaps be worth while to attend to this in buying and selling precious commodities; such as pearls, diamonds, silk, and some drugs. As they are generally sold by brass or leaden weights, the buyer will have some advantage when the air is heavy and the barometer high. On the other hand, he will have the advantage in buying gold and mercury when the air is light. It is needless to confine this observation to precious commodities, for the advantage is the same in all in proportion to their levity.

66 There is a case in which this observation is of consequence to the philosopher: we mean the measuring of time by pendulums. As the accelerating force on a pendulum is not its whole weight, but the excess of its weight over that of the displaced air, it follows that a pendulum will vibrate more slowly in the air than *in vacuo*. A pendulum composed of lead, iron, and brass, may be about 8400 times heavier than the air which it displaces when the barometer is at 30 inches and the thermometer at 32°, and the accelerating force will be diminished about $\frac{1}{10800}$. This will cause a second pendulum to make about five vibrations less in a day than it would do *in vacuo*. In order therefore to deduce the accelerative power of gravity from the length of a pendulum vibrating in the air, we must make an allowance of 0″,17, or $\frac{17}{100}$ of a second, per day for every inch that the barometer stands lower than 30 inches. But we must also note the temperature of the air; because when the air is warm it is less dense when supporting by its elasticity the same weight of atmosphere, and we must know how much its density is diminished by an increase of temperature. The correction is still more complicated; for the change of density affects the resistance of the air, and this affects the time of the vibration, and this by a law that is not yet well ascertained. As far as we can determine from any experiments that have been made, it appears that the change arising from the altered resistance takes off about $\frac{2}{5}$ of the change produced by the altered density, and that a second pendulum makes but three vibrations a-day more *in vacuo* than in the open air. This is a very unexpected result; but it must be owned that the experiments have neither been numerous nor very nicely made. Air-pump.

The air-pump also allows us to show the effects of the air's pressure in a great number of amusing and instructive phenomena.

When the air is abstracted from the receiver, it is strongly pressed to the pump-plate by the incumbent atmosphere, and it supports this great pressure in consequence of its circular form. Being equally compressed on all sides, there is no place where it should give way rather than another; but if it be thin, and not very round, which is sometimes the case, it will be crushed to pieces. If we take a square thin phial, and apply an exhausting syringe to its mouth, it will not fail being crushed. 167 Experiments to show the effects of the air's pressure.

As the operation of pumping is something like sucking, many of these phenomena are in common discourse ascribed to suction, a word much abused; and this abuse misleads the mind exceedingly in its contemplation of natural phenomena. Nothing is more usual than to speak of the suction of a syringe, the suction and draught of a chimney, &c. The following experiment puts the true cause of the strong adhesion of the receiver beyond a doubt.

Place a small receiver or cupping-glass on the pump-plate without covering the central hole, as represented in fig. 32. and cover it with a larger receiver. Exhaust the air from it; then admit it as suddenly as possible. The outer receiver, which after the rarefaction adhered strongly to the plate, is now loose, and the cupping-glass will be found sticking fast to it. While the rarefaction was going on, the air in the small receiver also expanded, escaped from it, and was abstracted by the pump. When the external air was suddenly admitted, it pressed on the small receiver, and forced it down to the plate, and thus shut up all entry. The small receiver must now adhere; and there can be no suction, for the pipe of the pump was on the outside of the cupping-glass. Plate CCCCIII.

This experiment sometimes does not succeed, because the air sometimes finds a passage under the brim of the cupping-glass. But if the cupping-glass be pressed down by the hand on the greasy leather or plate, every thing will be made smooth, and the glass will be so little raised by the expansion of its air during the pumping, that it will instantly clap close when the air is re-admitted.

In like manner, if a thin square phial be furnished with a valve, opening from within, but shutting when pressed from without, and if this phial be put under a receiver, and the air be abstracted from the receiver, the air in the phial will expand during the rarefaction, will escape through the valve, and be at last in a very rarefied state within the phial. If the air be now admitted into the receiver, it will press on the flat sides of the included phial and crush it to pieces. See fig. 33. 168

If a piece of wet ox-bladder be laid over the top of a receiver whose orifice is about four inches wide, and the 169

Air-pump the air be exhausted from within it, the incumbent atmosphere will press down the bladder into a hollow form, and then burst it inward with a prodigious noise. See fig. 34. Or if a piece of thin flat glass be laid over the receiver, with an oiled leather between them to make the juncture air-tight, the glass will be broken downwards. This must be done with caution, because the pieces of glass sometimes fly about with great force.

Plate CCCCII.

170 If there be formed two hemispherical cups of brass, with very flat thick brims, and one of them be fitted with a neck and stopcock, as represented by fig. 35. the air may be abstracted from them by screwing the neck into the hole in the pump-plate. To prevent the insinuation of air, a ring of oiled leather may be put between the rims. Now unscrew the sphere from the pump, and fix hooks to each, and suspend them from a strong nail, and hang a scale to the lowest. It will require a considerable weight to separate them; namely, about 15 pounds for every square inch of the great circle of the sphere. If this be four inches diameter, it will require near 190 pounds. This pretty experiment was first made by Otto Guericke, and on a very great scale. His sphere was of a large size, and, when exhausted, the hemispheres could not be drawn asunder by 20 horses. It was exhibited, along with many others equally curious and magnificent, to the Emperor of Germany and his court, at the breaking up of the diet of Ratisbon in 1654.

171 If the loaded syringe mentioned in n° 16. be suspended by its piston from the hook in the top plate of the receiver, as in fig. 36. and the air be abstracted by the pump, the syringe will gradually descend (because the elasticity of the air, which formerly balanced the pressure of the atmosphere, is now diminished by its expansion, and is therefore no longer able to press the syringe to the piston), and it will at last drop off. If the air be admitted before this happens, the syringe will immediately rise again.

172 Screw a short brass pipe into the neck of a transporter, n° 107. on which is set a tall receiver, and immerse it into a cistern of water. On opening the cork the pressure of the air on the surface of the water in the cistern will force it up through the pipe, and cause it to spout into the receiver with a strong jet, because there is no air within to balance by its elasticity the pressure of the atmosphere. See fig. 37.

173 By means of this pressure the gage of an air-pump acts,

It is in the same way that the gage of the air-pump performs its office. The pressure of the atmosphere raises the mercury in the gage till the weight of the mercury, together with the remaining elasticity of the air in the receiver, are in equilibrio with the whole pressure of the atmosphere: therefore the height and weight of the mercury in the gage is the excess of the weight of the atmosphere above the elasticity of the included air; and the deficiency of this height from that of the mercury in the Toricellian tube is the measure of this remaining elasticity.

174 If a Toricellian tube be put under a tall receiver, as shown in fig. 38. and the air be exhausted, the mercury in the tube will descend while that in the gage will rise; and the sum of their heights will always be the same, that is, equal to the height in an ordinary barometer. The height of the mercury in the receiver is the effect and measure of the remaining elasticity of the included air, and the height in the pump-gage is the unbalanced pressure of the atmosphere. This is a very instructive experiment, perfectly similar to Mr Auzout's, mentioned in n° 34. and completely establishes and illustrates the whole doctrine of atmospheric pressure.

175 Water in pumps

We get a similar illustration and confirmation (if such a thing be now needed) of the cause of the rise of water in pumps, by screwing a syringe into the top plate of a receiver, which syringe has a short glass pipe plunging into a small cup of water. See fig. 39. When the piston-rod is drawn up, the water rises in the glass pipe, as in any other pump, of which this is a miniature representation. But if the air has been previously exhausted from the receiver, there is nothing to press on the water in the little jar; and it will not rise in the glass pipe though the piston of the syringe be drawn to the top.

176 and motion in syphons

Analagous to the rise of water in pumps is its rise and motion in syphons. Suppose a pipe ABCD, fig. 40. bent at right angles at B and C, and having its two ends immersed in the cisterns of water A and D. Let the leg CD be longer than the leg BA, and let the whole be full of water. The water is pressed upwards at A with a force equal to the weight of the column of air EA reaching to the top of the atmosphere; but it is pressed downwards by the weight of the column of water BA. The water at E is pressed downwards by the weight of the column CD, and upwards by the weight of the column of air FD reaching to the top of the atmosphere. The two columns of air differ very little in their weight, and may without any sensible error be considered as equal. Therefore there is a superiority of pressure downwards at D, and the water will flow out there. The pressure of the air will raise the water in the leg AB, and thus the stream will be kept up till the vessel A is emptied as low as the orifice of the leg BA, provided the height of AB is not greater than what the pressure of the atmosphere can balance, that is, does not exceed 32 or 33 feet for water, 30 inches for mercury, &c.

A syphon then will always run from that vessel whose surface is highest; the form of the pipe is indifferent, because the hydrostatical pressures depend on the vertical height only. It must be filled with water by some other contrivance, such as a funnel, or a pump applied a-top; and the funnel must be stopped up, otherwise the air would get in, and the water would fall in both legs.

If the syphon have equal legs, as in fig. 41. and be turned up at the ends, it will remain full of water, and be ready for use. It need only be dipped into any vessel of water, and the water will then flow out at the other end of the syphon. This is call the *Wirtinberg syphon*, and is represented in fig. 41. Syphons will afterwards be considered more minutely under the title of *Pneumatical Engines*, at the end of this article. 177

178 The syphon fountain

What is called the *syphon fountain*, constructed on this principle, is shown in fig. 42. where AB is a tall receiver, standing in a wide bason DE, which is supported on the pedestal H by the hollow pillar FG. In the centre of the receiver is a jet pipe C, and in the top a ground stopper A. Near the base of the pillar is a cock N, and in the pedestal is another cock O.

Fill the bason DE with water within half an inch of the brim. Then pour in water at the top of the receiver (the cock N being shut) till it is about half full,

 and

tri- on &c. and then put in the ftopper. A little water will run out into the veffel DE. But before it runs over, open the cock N, and the water will run into the ciftern H; and by the time that the pipe C appears above water, a jet will rife from it, and continue as long as water is fupplied from the bafon DE. The paffage into the bafe ciftern may be fo tempered by the cock N that the water within the receiver fhall keep at the fame height, and what runs into the bafe may be received from the cock O into another veffel, and returned into DE, to keep up the ftream.

9 er of ftruc- nd tion. ate CIII. This pretty philofophical toy may be conftructed in the following manner. BB, fig. 42. n° 2. is the ferril or cap into which the receiver is cemented. From its centre defcends the jet pipe C*a*, floping outwards, to give room for the difcharging pipe *b d* of larger diameter, whofe lower extremity *d* fits tightly into the top of the hollow pillar FG.

The operation of the toy is eafily underftood. Suppofe the diftance from C to H (n° 1.) three feet, which is about $\frac{1}{11}$ of the height at which the atmofphere would fupport a column of water. The water poured into AB would defcend through FG (the hole A being fhut) till the air has expanded $\frac{1}{10}$, and then it would ftop. If the pipe C*a* be now opened, the preffure of the air on the furface of the water in the ciftern DE will caufe it to fpout through C to the height of three feet nearly, and the water will continue to defcend through the pipe FG. By tempering the cock N fo as to allow the water to pafs through it as faft as it is fupplied by the jet, the amufement may be continued a long time. It will ftop at laft, however; becaufe, as the jet is made into rarefied air, a little air will be extricated from the water, which will gradually accumulate in the receiver, and diminifh its rarefaction, which is the moving caufe of the jet. This indeed is an inconvenience felt in every employment of fyphons, fo much the more remarkably as their top is higher than the furface of the water in the ciftern of fupply.

80 ons ften thus. Cafes of this employment of a fyphon are not unfrequent. When water collected at A (fig. 43.) is to be conducted in a pipe to C, fituated in a lower part of the country, it fometimes happens, as between Lochend and Leith, that the intervening ground is higher than the fountain-head as at B. A forcing pump is erected at A, and the water forced along the pipe. Once it runs out at C, the pump may be removed, and the water will continue to run on the fyphon principle, provided BD do not exceed 33 feet. But the water in that part of the conduit which is above the horizontal plane AD, is in the fame ftate as in a receiver of rarefied air, and gives out fome of the air which is chemically united with it. This gradually accumulates in the elevated part of the conduit, and at laft choaks it entirely. When this happens, the forcing pump muft again be worked. Although the elevation in the Leith conduit is only about eight or ten feet, it will feldom run for 12 hours. N. B. This air cannot be difcharged by the ufual air-cocks; for if there were an opening at B, the air would rufh in, and immediately ftop the motion.

81 air- dif- rs the bina- of air water, This combination of air with water is very diftinctly feen by means of the air-pump. If a fmall glafs containing cold water, frefh drawn from the fpring, be expofed, as in fig. 44. under the receiver, and the air rarefied, fmall bubbles will be obferved to form on the inner furface of the glafs, or on the furface of any body immerfed in it, which will increafe in fize, and then detach themfelves from the glafs and reach the top; as the rarefaction advances, the whole water begins to fhow very minute air-bubbles rifing to the top; and this appearance will continue for a very long time, till it be completely difengaged. Warming the water will occafion a ftill farther feparation of air, and a boiling heat will feparate all that can be difengaged. The reafon affigned for thefe air-bubbles firft appearing on the furface of the glafs, &c. is, that air is attracted by bodies, and adheres to their furface. This may be fo. But it is more probably owing to the attraction of the water for the glafs, which caufes it to quit the air which it held in folution, in the fame manner as we fee it happen when it is mixed with fpirits-of-wine, with vitriolic acid, &c. or when falts or fugar are diffolved in it. For if we pour out the water which has been purged of air by boiling *in vacuo*, and fill the glafs with frefh water, we fhall obferve the fame thing, although a film of the purified water was left adhering to the glafs. In this cafe there can be no air adhering to the glafs.

Elafticity, &c. Plate CCCCIV.

Water thus purged of air by boiling (or even without boiling) *in vacuo*, will again abforb air when expofed to the atmofphere. The beft demonftration of this is to fill with this water a phial, leaving about the fize of a pea not filled. Immerfe this in a veffel of water, with the mouth undermoft, by which means the air-bubble will mount up to the bottom of the phial. After fome days ftanding in this condition, the air-bubble will be completely abforbed, and the veffel quite filled with water. 182

The air in this ftate of chemical folution has loft its elafticity, for the water is not more compreffible than common water. It is alfo found that water brought up from a great depth under ground contains much more air than water at the furface. Indeed fountain waters differ exceedingly in this refpect. The water which now comes into the city of Edinburgh by pipes contains fo much as to throw it into a confiderable ebullition *in vacuo*. Other liquors contain much greater quantities of elaftic fluids in this loofely combined ftate. A glafs of beer treated in the fame way will be almoft wholly converted into froth by the efcape of its fixed air, and will have loft entirely the prickling fmartnefs which is fo agreeable, and it become quite vapid. 183

The air-pump gives us, in the next place, a great variety of experiments illuftrative of the air's elafticity and expanfibility. The very operation of exhauftion, as it is called, is an inftance of its great, and hitherto unlimited, expanfibility. But this is not palpably exhibited to view. The following experiments fhow it moft diftinctly. And illuftrates the air's elafticity and expanfibility. 184

1ft, Put a flaccid bladder, of which the neck is firmly tied with a thread, under a receiver, and work the pump. The bladder will gradually fwell, and will even be fully diftended. Upon readmitting the air into the receiver, the bladder gradually collapfes again into its former dimenfions: while the bladder is flaccid, the air within it is of the fame denfity and elafticity with the furrounding air, and its elafticity balances the preffure of the atmofphere. When part of the air of the receiver is abftracted, the remainder expands fo Experiments fhowing thefe properties.

Experiments on Air.

as ſtill to fill the receiver: but by expanding, its elaſticity is plainly diminiſhed; for we ſee by the fact, that the elaſticity of the air of the receiver no longer balances the elaſticity of that in the bladder, as it no longer keeps it in its dimenſions. The air in the bladder expands alſo: it expands till its diminiſhed elaſticity is again in equilibrio with the diminiſhed elaſticity of the air in the receiver; that is, till its denſity is the ſame. When all the wrinkles of the bladder have diſappeared, its air can expand no more, although we continue to diminiſh the elaſticity of the air of the receiver by further rarefaction. The bladder now tends to burſt; and if it be pierced by a point or knife faſtened to the ſlip-wire, the air will ruſh out, and the mercury deſcend rapidly in the gage.

185 If a phial or tube be partly filled with water, and immerſed in a veſſel of water with the mouth downwards, the air will occupy the upper part of the phial. If this apparatus be put under a receiver, and the air be abſtracted, the air in the phial will gradually expand, allowing the water to run out by its weight till the ſurface of the water be on a level within and without. When this is the caſe, we muſt grant that the denſity and elaſticity of the air in the phial is the ſame with that in the receiver. When we work the pump again, we ſhall obſerve the air in the phial expand ſtill more, and come out of the water in bubbles. Continuing the operation, we ſhall ſee the air continually eſcaping from the phial: when this is over, it ſhows that the pump can rarefy no more. If we now admit the air into the receiver, we ſhall ſee the water riſe into the phial, and at laſt almoſt completely fill it, leaving only a very ſmall bubble of air at top. This bubble had expanded ſo as to fill the whole phial. See this repreſented in fig. 45.

Plate CCCCIV.

186 Every one muſt have obſerved a cavity at the big end of an egg between the ſhell and the white. The white and yolk are contained in a thin membrane or bladder which adheres looſely to the ſhell, but is detached from it at that part; and this cavity increaſes by keeping the egg in a dry place. One may form a judgment of its ſize, and therefore of the freſhneſs of the egg, by touching it with the tongue; for the ſhell, where it is not in contact with the contents, will preſently feel warm, being quickly heated by the tongue, while the reſt of the egg will feel cold.

If a hole be made in the oppoſite end of the egg, and it be ſet on a little tripod, and put under a receiver, the expanſion of the air in the cavity of the egg will force the contents through the hole till the egg be quite emptied: or, if nearly one half of the egg be taken away at the other end, and the white and yolk taken out, and the ſhell be put under a receiver, and the air abſtracted, the air in the cavity of the egg will expand, gradually detaching the membrane from the ſhell, till it cauſes it to ſwell out, and gives the whole the appearance of an entire egg.—In like manner ſhrivelled apples and other fruits will ſwell in vacuo by the expanſion of the air confined in their cavities.

187 If a piece of wood, a twig with green leaves, charcoal, plaſter of Paris, &c. be kept under water in vacuo, a prodigious quantity of air will be extracted; and if we readmit the air into the receiver, it will force the water into the pores of the body. In this caſe the body will not ſwim in water as it did before, ſhowing that the vegetable fibres are ſpecifically heavier than water. It is found, however, that the air contained in the pith and bark, ſuch as cork, is not all extricated in this way; and that much of it is contained in veſicles which have no outlet: being ſecreted into them in the proceſs of vegetation, as it is ſecreted into the air-bladder of fiſhes, where it is generally found in a pretty compreſſed ſtate, conſiderably denſer than the ſurrounding air. The air-bladder of a fiſh is ſurrounded by circular and longitudinal muſcles, by which the fiſh can compreſs the air ſtill further; and, by ceaſing to act with them, allow it to ſwell out again. It is in this manner that the fiſh can ſuit its ſpecific gravity to its ſituation in the water, ſo as to have no tendency either to riſe or ſink: but if the fiſh be put into the receiver of an air-pump, the rarefaction of the air obliges the fiſh to act more ſtrongly with theſe contracting muſcles, in order to adjuſt its ſpecific gravity; and if too much air has been abſtracted from the receiver, the fiſh is no longer able to keep its air-bladder in the proper degree of compreſſion. It becomes therefore too buoyant, and comes to the top of the water, and is obliged to ſtruggle with its tail and fins in order to get down; frequently in vain. The air-bladder ſometimes burſts, and the fiſh goes to the bottom, and can no longer keep above without the continual action of its tail and fins. When fiſhes die, they commonly float at top, their contractive action being now at an end. All this may be illuſtrated (but very imperfectly) by a ſmall half-blown bladder, to which is appended a bit of lead, juſt ſo heavy as to make it ſink in water: when this is put under a receiver, and the air abſtracted, the bubble will riſe to the top; and, by nicely adjuſting the rarefaction, it may be kept at any height. See fig. 46.

The play-things called *Carteſian devils* are ſimilar to this: they are hollow glaſs figures, having a ſmall aperture in the lower part of the figures, as at the point of the foot; their weight is adjuſted ſo that they ſwim upright in water. When put into a tall jar filled to the top, and having a piece of leather tied over it, they will ſink in the water, by preſſing on the leather with the ball of the hand: this, by compreſſing the water, forces ſome of it to enter into the figure and makes it heavier than the water; for which reaſon it ſinks, but riſes again on removing the preſſure of the hand. See fig. 47, nº 1. and 2. 188

If a half-blown ox-bladder be put into a box, and great weights laid on it, and the whole be put under a receiver, and the air abſtracted; the air will, by expanding, lift up the weights, though above an hundred pounds. See fig. 48.

189 Compreſſibility and expanſibility are no ſtate of the air diſſimilar.

By ſuch experiments the great expanſibility of the air is abundantly illuſtrated, as its compreſſibility was formerly by means of the condenſing ſyringe. We now ſee that the two ſets of experiments form an uninterrupted chain; and that there is no particular ſtate of the air's denſity where the compreſſibility and expanſibility is remarkably diſſimilar. Air in its ordinary ſtate expands; becauſe its ordinary ſtate is a ſtate of compreſſion by the weight of the atmoſphere: and if there were a pit about 33 miles deep, the air at the bottom would probably be as denſe as water; and if it were 50 miles deep, it would be as denſe as gold, if it did not become a liquid before this depth: nay, if a bottle with its mouth undermoſt were immerſed ſix miles under water, it would probably be as denſe as water; we ſay probably, for this depends on the nature of its compreſſibility

fibility; that is, on the relation which subsists between the compression and the force which produces it.

This is the circumstance of its constitution, which we now proceed to examine; and it is evidently a very important circumstance. We have long ago observed, that the great compressibility and permanent fluidity of air, observed in a vast variety of phenomena, is totally inexplicable, on the supposition that the particles of air are like so many balls of sponge or so many foot-balls. Give to those what compressibility you please, common air could no more be fluid than a mass of clay; it could no more be fluid than a mass of such balls pressed into a box. It can be demonstrated (and indeed hardly needs a demonstration), that before a parcel of such balls, just touching each other, can be squeezed into half their present dimensions, their globular shape will be entirely gone, and each will have become a perfect cube, touching six other cubes with its whole surface; and these cubes will be strongly compressed together, so that motion could never be performed through among them by any solid body without a very great force. Whereas we know that in this state air is just as permeable to every body as the common air that we breathe. There is no way in which we can represent this fluidity to our imagination but by conceiving air to consist of particles, not only discrete, but distant from each other, and actuated by repulsive forces, or something analogous to them. It is an idle subterfuge, to which some naturalists have recourse, saying, that they are kept asunder by an intervening ether, or elastic fluid of any other name. This is only removing the difficulty a step farther off: for the elasticity of this fluid requires the same explanation; and therefore it is necessary, in obedience to the rules of just reasoning, to begin the inquiry here; that is, to determine from the phenomena what is the analogy between the distances of the particles and the repulsive forces exerted at these distances, proceeding in the same way as in the examination of planetary gravitation. We shall learn the analogy by attending to the analogy between the compressing force and the density.

For the density depends on the distance between the particles; the nearer they are to each other, the denser is the air. Suppose a square pipe one inch wide and eight inches long, shut at one end, and filled with common air; then suppose a plug so nicely fitted to this pipe that no air can pass by it sides; suppose this piston thrust down to within an inch of the bottom: it is evident that the air which formerly filled the whole pipe now occupies the space of one cubic inch, which contains the same number of particles as were formerly diffused over eight cubic inches.

The condensation would have been the same if the air which fills a cube whose side is two inches had been squeezed into a cube of one inch, for the cube of two inches also contains eight inches. Now, in this case it is evident that the distance between the particles would be reduced to its half in every direction. In like manner, if a cube whose side is three inches, and which therefore contains 27 inches, be squeezed into one inch, the distance of the particles will be one third of what it was: in general the distance of the particles will be as the cube-root of the space into which they are compressed. If the space be $\frac{1}{8}$, $\frac{1}{27}$, $\frac{1}{64}$, $\frac{1}{125}$, &c. of its former dimensions, the distance of the particles will be $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, &c. Now the term *density*, in its strict sense, expresses the vicinity of the particles; *densi arbores* are trees growing near each other. The measure of this vicinity therefore is the true measure of the density; and when 27 inches of air are compressed into one, we should say that it is three times as dense; but we say, that it is 27 times denser.

192 Farther explanation.

Density is therefore used in a sense different from its strictest acceptation: it expresses the comparative number of equidistant particles contained in the same bulk. This is also abundantly precise, when we compare bodies of the same kind, differing in density only; but we also say, that gold is 19 times denser than water, because the same bulk of it is 19 times heavier. This assertion proceeds on the assumption, or the fact, that every ultimate atom of terrestrial matter is equally heavy: a particle of gold may contain more or fewer atoms of matter than a particle of water. In such a case, therefore, the term density has little or no reference to the vicinity of the particles; and is only a term of comparison of other qualities or accidents.

But when we speak of the respective densities of the same substance in its different states of compression, the word *density* is strictly connected with vicinity of particles, and we may safely take either of the measures. We shall abide by the common acceptation, and call that air eight times as dense which has eight times as many particles in the same bulk, although the particles are only twice as near to each other.

193 The analogy between the compressing force and the distance of the particles, &c.

Thus then we see, that by observing the analogy between the compressing force and the density, we shall discover the analogy between the compressing force and the distance of the particles. Now the force which is necessary for compressing two particles of air to a certain vicinity is a proper measure of the elasticity of the particles corresponding to that vicinity or distance; for it balances it, and forces which balance must be esteemed equal. Elasticity is a distinctive name for that corpuscular force which keeps the particles at that distance: therefore observations made on the analogy between the compressing force and the density of air will give us the law of its corpuscular force, in the same way that observations on the simultaneous deflections of the planets towards the sun give us the law of celestial gravitation.

194

But the sensible compressing forces which we are able to apply is at once exerted on unknown thousands of particles, while it is the law of action of a single particle that we want to discover. We must therefore know the *proportion* of the numbers of particles on which the compressing force is exerted. It is easy to see, that since the distance of the particles is as the cube root of the density inversely, the number of particles in physical contact with the compressing surface must be as the square of this root. Thus when a cube of 8 inches is compressed into one inch, and the particles are twice as near each other as they were before, there must be four times the number of particles in contact with each of the sides of this cubical inch; or, when we have pushed down the square piston of the pipe spoken of above to within an inch of the bottom, there will be four times the number of particles *immediately* contiguous to the piston, and resisting the compression; and in order to obtain the force really exerted on one particle, and the elasticity of that particle, we must divide the whole compressing force by 4. In like manner, if we have com-

 pressed

Experiments on Air.

preffed air into $\frac{1}{27}$ of its former bulk, and brought the particles to $\frac{1}{3}$ of their former diftance, we muft divide the compreffing force by 9. In general if d exprefs the denfity, $\frac{1}{\sqrt[3]{d}}$ will exprefs the diftance x of the particles; $\sqrt[3]{d}$, or $d^{\frac{1}{3}}$, will exprefs the vicinity or real denfity; and $d^{\frac{2}{3}}$ will exprefs the number of particles acting on the compreffing furface: and if f exprefs the accumulated external compreffing force, $\frac{f}{d^{\frac{2}{3}}}$ will exprefs the force acting on one particle; and therefore the elafticity of that particle correfponding to the diftance x.

195 Experiments eftablifhing the law of compreffion.

We may now proceed to confider the experiments by which the law of compreffion is to be eftablifhed.

The firft experiments to this purpofe were thofe made by Mr Boyle, publifhed in 1661 in his *Defenfio Doctrinæ de Aeris Elatere contra Linum*, and exhibited before the Royal Society the year before. Mariotte made experiments of the fame kind, which were publifhed in 1676 in his *Effai fur la Nature de l'Air* and *Traité des Mouvemens des Eaux*. The moft copious experiments are thofe by Sulzer (*Mem. Berlin.* ix.), thofe by Fontana (*Opufc. Phyfico-Math.*), and thofe by Sir George Shuckbourgh and Gen. Roy.

196 Compreffibility of air not rarer than the atmofphere at the earth's furface. Plate CCCCIV.

In order to examine the compreffibility of air that is not rarer than the atmofphere at the furface of the earth, we employ a bent tube or fyphon ABCD (fig. 49.), hermetically fealed at A and open at D. The fhort leg AB muft be very accurately divided in the proportion of its folid contents, and fitted with a fcale whofe units denote equal increments, not of length, but of capacity. There are various ways of doing this; but it requires the moft fcrupulous attention, and without this the experiments are of no value. In particular, the arched form at A muft be noticed. A fmall quantity of mercury muft then be poured into the tube, and paffed backwards and forwards till it ftands (the tube being held in a vertical pofition) on a level at B and C. Then we are certain that the included air is of the fame denfity with that of the contiguous atmofphere. Mercury is now poured into the leg DC, which will fill it, fuppofe to G, and will comprefs the air into a fmaller fpace AE. Draw the horizontal line EF: the new bulk of the compreffed air is evidently AE, meafured by the adjacent fcale, and the addition made to the compreffing force of the atmofphere is the weight of the column GF. Produce GF downwards to H, till FH is equal to the height fhown by a Toricellian tube filled with the *fame mercury;* then the whole compreffing force is HG. This is evidently the meafure of the elafticity of the compreffed air in AE, for it balances it. Now pour in more mercury, and let it rife to g, compreffing the air into A e. Draw the horizontal line ef, and make fh equal to FH; then A e will be the new bulk of the compreffed air, $\frac{AB}{Ae}$ will be its new denfity, and hg will be the meafure of the new elafticity. This operation may be extended as far as we pleafe, by lengthening the tube CD, and taking care that it be ftrong enough to refift the great preffure. Great care muft be taken to keep the whole in a conftant temperature, becaufe the elafticity of air is greatly affected by heat, and the change by any increafe of temperature is different according to its denfity or compreffion.

197 Experiments of Boyle, &c. neither nicely made, nor extended to great compreffions.

The experiments of Boyle, Mariotte, Amontons, and others, were not extended to very great compreffions, the denfity of the air not having been quadrupled in any of them; nor do they feem to have been made with very great nicety. It may be collected from them in general, that the elafticity of the air is very nearly proportioned to its denfity; and accordingly this law was almoft immediately acquiefced in, and was called the *Boylean law:* it is accordingly affumed by almoft all writers on the fubject as exact. Of late years, however, there occurred queftions in which it was of importance that this point fhould be more fcrupuloufly fettled, and the former experiments were repeated and extended. Sulzer and Fontana have carried them farther than any other. Sulzer compreffed air into $\frac{1}{8}$ of its former dimenfions.

198 Varieties, &c. in thefe experiments.

Confiderable varieties and irregularities are to be obferved in thefe experiments. It is extremely difficult to preferve the temperature of the apparatus, particularly of the leg AB, which is moft handled. A great quantity of mercury muft be employed; and it does not appear that philofophers have been careful to have it precifely fimilar to that in the barometer, which gives us the unit of compreffing force and of elafticity. The mercury in the barometer fhould be pure and boiled. If the mercury in the fyphon is adulterated with bifmuth and tin, which it commonly is to a confiderable degree, the compreffing force, and confequently the elafticity, will appear greater than the truth. If the barometer has not been nicely fitted, it will be lower than it fhould be, and the compreffing force will appear too great, becaufe the unit is too fmall; and this error will be moft remarkable in the fmaller compreffions.

199 Heterogeneous mixture of air the greateft fource of error.

The greateft fource of error and irregularity in the experiments is the very heterogeneous nature of the air itfelf. Air is a folvent of all fluids, all vapours, and perhaps of many folid bodies. It is highly improbable that the different compounds fhall have the fame elafticity, or even the fame law of elafticity: and it is well known, that air, loaded with water or other volatile bodies, is much more expanfible by heat than pure air; nay, it would appear from many experiments, that certain determinate changes both of denfity and of temperature, caufe air to let go the vapours which it holds in folution. Cold caufes it to precipitate water, as appears in dew; fo does rarefaction, as is feen in the receiver of an air-pump.

200 The elafticity does not increafe fo faft as the denfity.

In general, it appears that the elafticity of air does not increafe quite fo faft as its denfity. This will be beft feen by the following tables, calculated from the experiments of Mr Sulzer. The column E in each fet of experiments expreffes the length of the column GH, the unit being FH, while the column D expreffes $\frac{AB}{AE}$.

1ft

peri- nts on Air.

1st Set.		2d Set.		3d Set.	
D	E	D	E	D	E
1,000	1,000	1,000	1,000	1,000	1,000
1,100	1,093	1,236	1,224	1,091	1,076
1,222	1,211	1,294	1,288	1,200	1,183
1,375	1,284	1,375	1,332	1,333	1,303
1,571	1,559	1,466	1,414	1,500	1,472
1,692	1,669	1,571	1,515	1,714	1,659
1,833	1,796	1,692	1,647		
2,000	1,958	2,000	1,964	2,000	1,900
2,288	2,130				
2,444	2,375	2,444	2,392	2,400	2,241
3,143	2,936	3,143	3,078	3,000	2,793
3,666	3,391	3,666	3,575		
4,000	3,706			4,000	3,631
4,444	4,035	4,444	4,320		
4,888	4,438				
5,500	4,922	5,500	5,096		
5,882	5,522			6,000	5,297
		7,333	6,694		
				8,000	6,835

201 There appears in these experiments sufficient grounds for calling in question the Boylean law; and the writer of this article thought it incumbent on him to repeat them with some precautions, which probably had not been attended to by Mr Sulzer. He was particularly anxious to have the air as free as possible from moisture. For this purpose, having detached the short leg of the syphon, which was 34 inches long, he boiled mercury in it, and filled it with mercury boiling hot. He took a tinplate vessel of sufficient capacity, and put into it a quantity of powdered quicklime just taken from the kiln; and having closed the mouth, he agitated the lime through the air in the vessel, and allowed it to remain there all night. He then emptied the mercury out of the syphon into this vessel, keeping the open end far within it. By this means the short leg of the syphon was filled with very dry air. The other part was now joined, and boiled mercury put into the bend of the syphon; and the experiment was then prosecuted with mercury which had been recently boiled, and was the same with which the barometer had been carefully filled.

202 The results of the experiments are expressed in the following table.

Dry Air.		Moist Air.		Camp. Air.	
D	E	D	E	D	E
1,000	1,000	1,000	1,000	1,000	1,000
2,000	1,957	2,000	1,920	2,000	1,909
3,000	2,848	3,000	2,839	3,000	2,845
4,000	3,737	4,000	3,726	4,000	3,718
5,500	4,930	5,500	5,000	5,500	5,104
6,000	5,342	6,000	5,452	6,000	5,463
7,620	6,490	7,620	6,775	7,620	6,812

Here it appears again in the clearest manner that the elasticities do not increase as fast as the densities, and the differences are even greater than in Mr Sulzer's experiments.

203 The second table contains the results of experiments made on very damp air in a warm summer's morning. In these it appears that the elasticities are almost precisely proportional to the densities + a small constant quantity, nearly 0,11 deviating from this rule chiefly between the densities 1 and 1,5, within which limits we have very nearly $D = E^{1.0017}$. As this air is nearer to the constitution of atmospheric air than the former, this rule may be safely followed in cases where atmospheric air is concerned, as in measuring the depths of pits by the barometer. Elasticity.

The third table shows the compression and elasticity of air strongly impregnated with the vapours of camphire. Here the Boylean law appears pretty exact, or rather the elasticity seems to increase a little faster than the density. 204

Dr Hooke examined the compression of air by immersing a bottle to great depths in the sea, and weighing the water which got into it without any escape of air. But this method was liable to great uncertainty, on account of the unknown temperature of the sea at great depths. 205

Hitherto we have considered only such air as is not rarer than what we breathe; we must take a very different method for examining the elasticity of rarefied air. 206 Mode of examining the elasticity of rarefied air.

Let $g\,h$ (fig. 50.) be a long tube, formed a-top into a cup, and of sufficient diameter to receive another smaller tube $a\,f$, open at first at both ends. Let the outer tube and cup be filled with mercury, which will rise in the inner tube to the same level. Let $a\,f$ now be stopped at a. It contains air of the same density and elasticity with the adjoining atmosphere. Note exactly the space $a\,b$ which it occupies. Draw it up into the position of fig. 51. and let the mercury stand in it at the height $d\,e$, while $c\,e$ is the height of the mercury in the barometer. It is evident that the column $d\,e$ is in equilibrio between the pressure of the atmosphere and the elasticity of the air included in the space $a\,d$. And since the weight of $c\,e$ would be in equilibrio with the whole pressure of the atmosphere, the weight of $c\,d$ is equivalent to the elasticity of the included air. While therefore $c\,e$ is the measure of the elasticity of the surrounding atmosphere, $c\,d$ will be the measure of the elasticity of the included air; and since the air originally occupied the space $a\,b$, and has now expanded into $a\,d$, we have $\frac{a\,b}{a\,d}$ for the measure of its density. N. B. $c\,e$ and $c\,d$ are measured by the *perpendicular heights* of the columns, but $a\,b$ and $a\,d$ must be measured by their *solid capacities*. Plate CCCCIV.

By raising the inner tube still higher, the mercury will also rise higher, and the included air will expand still farther, and we obtain another $c\,d$, and another $\frac{a\,b}{a\,d}$; and in this manner the relation between the density and elasticity of rarefied air may be discovered. 207

This examination may be managed more easily by means of the air-pump. Suppose a tube $a\,e$ (fig. 52.) containing a small quantity of air $a\,b$, set up in a cistern of mercury, which is supported in the tube at the height $e\,b$, and let $e\,c$ be the height of the mercury in the barometer. Let this apparatus be set under a tubulated receiver on the pump-plate, and let $g\,n$ be the pump-gage, and $m\,n$ be made equal to $c\,e$. 208 An easier method by means of the air-pump.

Then,

Experiments on Air.

Then, as has been already shown, cb is the measure of the elasticity of the air in ab, corresponding to the bulk ab. Now let some air be abstracted from the receiver. The elasticity of the remainder will be diminished by its expansion; and therefore the mercury in the tube ae will descend to some point d. For the same reason, the mercury in the gage will rise to some point o, and mo will express the elasticity of the air in the receiver. This would support the mercury in the tube ae at the height er, if the space ar were entirely void of air. Therefore rd is the effect and measure of the elasticity of the included air when it has expanded to the bulk ad; and thus its elasticity, under a variety of other bulks, may be compared with its elasticity when of the bulk ab. When the air has been so far abstracted from the receiver that the mercury in ae descends to e, then mo will be the precise measure of its elasticity.

In all these cases it is necessary to compare its bulk ab with its natural bulk, in which its elasticity balances the pressure of the atmosphere. This may be done by laying the tube ae horizontally, and then the air will collapse into its ordinary bulk.

209 Another easy method Plate CCCCIV.

Another easy method may be taken for this examination. Let an apparatus $abcdef$ (fig. 53.) be made, consisting of a horizontal tube ae of even bore, a ball dge of a large diameter, and a swan-neck tube bf. Let the ball and part of the tube geb be filled with mercury, so that the tube may be in the same horizontal plane with the surface de of the mercury in the ball. Then seal up the end a, and connect f with an air-pump. When the air is abstracted from the surface de, the air in ab will expand into a larger bulk ac, and the mercury in the pump-gage will rise to some distance below the barometric height. It is evident that this distance, without any farther calculation, will be the measure of the elasticity of the air pressing on the surface de, and therefore of the air in ac.

210 The most exact mode of examining this elasticity.

The most exact of all methods is to suspend in the receiver of an air-pump a glass vessel, having a very narrow mouth over a cistern of mercury, and then abstract the air till the gage rises to some determined height. The difference e between this height and the barometric height determines the elasticity of the air in the receiver and in the suspended vessel. Now lower down that vessel by the slip-wire till its mouth is immersed into the mercury, and admit the air into the receiver; it will press the mercury into the little vessel. Lower it still farther down, till the mercury within it is level with that without; then stop its mouth, take it out and weigh the mercury, and let its weight be w. Subtract this weight from the weight v of the mercury, which would completely fill the whole vessel; then the natural bulk of the air will be $v-w$, while its bulk, when of the elasticity e in the rarefied receiver, was the bulk or capacity w of the vessel. Its density therefore, corresponding to this elasticity e, was $\frac{v-w}{w}$.

And thus may the relation between the density and elasticity in all cases be obtained.

211 Various experiments have been made to this purpose.

A great variety of experiments to this purpose have been made, with different degrees of attention, according to the interest which the philosophers had in the result. Those made by M. de Luc, General Roy, Mr Trembley, and Sir George Shuckbourgh, are by far the most accurate; but they are all confined to very moderate rarefactions. The general result has been, that the elasticity of rarefied air is very nearly proportional to its density. We cannot say with confidence that any regular deviation from this law has been observed, there being as many observations on one side as on the other; but we think that it is not unworthy the attention of philosophers to determine it with precision in the cases of extreme rarefaction, where the irregularities are most remarkable. The great source of error is a certain adhesive sluggishness of the mercury when the impelling forces are very small; and other fluids can hardly be used, because they either smear the inside of the tube and diminish its capacity, or they are converted into vapour, which alters the law of elasticity.

Boylean Law.

212 The Boylean law m[ay] in general be assum[ed].

Let us, upon the whole, assume the Boylean law, *viz.* that the elasticity of the air is proportional to its density. The law deviates not in any sensible degree from the truth in those cases which are of the greatest practical importance, that is, when the density does not much exceed or fall short of that of ordinary air.

213 Investiga[tion] of the action of the particles on each other.

Let us now see what information this gives us with respect to the action of the particles on each other.

The investigation is extremely easy. We have seen that a force eight times greater than the pressure of the atmosphere will compress common air into the eighth part of its common bulk, and give it eight times its common density: and in this case we know, that the particles are at half their former distance, and that the number which are now acting on the surface of the piston employed to compress them is quadruple of the number which act on it when it is of the common density. Therefore, when this eightfold compressing force is distributed over a fourfold number of particles, the portion of it which acts on each is double. In like manner, when a compressing force 27 is employed, the air is compressed into $\frac{1}{27}$ of its former bulk, the particles are at $\frac{1}{3}$ of their former distance, and the force is distributed among 9 times the number of particles; the force on each is therefore 3. In short, let $\frac{1}{x}$ be the distance of the particles, the number of them in any given vessel, and therefore the density will be as x^3, and the number pressing by their elasticity on its whole internal surface will be as x^2. Experiment shows, that the compressing force is as x^3, which being distributed over the number as x^2, will give the force on each as x. Now this force is in immediate equilibrium with the elasticity of the particle immediately contiguous to the compressing surface. This elasticity is therefore as x: and it follows from the nature of perfect fluidity, that the particle adjoining to the compressing surface presses with an equal force on its adjoining particles on every side. Hence we must conclude, that the corpuscular repulsions exerted by the adjoining particles are inversely as their distances from each other, or that the adjoining particles tend to recede from each other with forces inversely proportional to their distances.

214 Sir Isaac Newton was the first who reasoned properly on this [sub]ject.

Sir Isaac Newton was the first who reasoned in this manner from the phenomena. Indeed he was the first who had the patience to reflect on the phenomena with any precision. His discoveries in gravitation naturally gave his thoughts this turn, and he very early hinted his suspicions that all the characteristic phenomena of tangible

7

tangible matter were produced by forces which were exerted by the particles at fmall and infenfible diftances: And he confiders the phenomena of air as affording an excellent example of this inveftigation, and deduces from them the law which we have now demonftrated; and fays, that air confifts of particles which avoid the adjoining particles with forces inverfely proportional to their diftances from each other. From this he deduces (in the 2d book of his Principles) feveral beautiful propofitions, determining the mechanical conftitution of the atmofphere.

15 But it muft be noticed that he limits this action to the *adjoining* particles: and this is a remark of immenfe confequence, though not attended to by the numerous experimenters who adopt the law.

It is plain that the particles are fuppofed to act at a diftance, and that this diftance is variable, and that the forces diminifh as the diftances increafe. A very ordinary air-pump will rarefy the air 125 times. The diftance of the particles is now 5 times greater than before; and yet they ftill repel each other: for air of this denfity will ftill fupport the mercury in a fyphon-gage at the height of 0,24, or $\frac{24}{100}$ of an inch; and a better pump will allow this air to expand twice as much, and ftill leave it elaftic. Thus we fee that whatever is the diftance of the particles of common air, they can act five times farther off. The queftion comes now to be, Whether, in the ftate of common air, they really do act five times farther than the diftance of the adjoining particles? While the particle *a* acts on the particle *b* with the force 5, does it alfo act on the particle *c* with the force 2,5, on the particle *d* with the force 1,667, on the particle *e* with the force 1,25, on the particle *f* with the force 1, on the particle *g* with the force 0,8333, &c?

16 Sir Ifaac Newton fhows in the plaineft manner, that this is by no means the cafe; for if this were the cafe, he makes it appear that the fenfible phenomena of condenfation would be totally different from what we obferve. The force neceffary for a quadruple condenfation would be eight times greater, and for a nonuple condenfation the force muft be 27 times greater. Two fpheres filled with condenfed air muft repel each other, and two fpheres containing air that is rarer than the furrounding air muft attract each other, &c. &c. All this will appear very clearly, by applying to air the reafoning which Sir Ifaac Newton has employed in deducing the fenfible law of mutual tendency of two fpheres, which confift of particles attracting each other with forces proportional to the fquare of the diftance inverfely.

17 If we could fuppofe that the particles of air repelled each other with invariable forces at all diftances within fome fmall and infenfible limit, this would produce a compreffibility and elafticity fimilar to what we obferve. For if we confider a row of particles, within this limit, as compreffed by an external force applied to the two extremities, the action of the whole row on the extreme points would be proportional to the number of particles, that is, to their diftance inverfely and to their denfity: and a number of fuch parcels, ranged in a ftraight line, would conftitute a row of any fenfible magnitude having the fame law of compreffion. But this law of corpufcular force is unlike every thing we obferve in nature, and to the laft degree improbable.

Height of the Atmofphere.

We muft therefore continue the limitation of this mutual repulfion of the particles of air, and be contented for the prefent with having eftablifhed it as an experimental fact, that the *adjoining* particles of air are kept afunder by forces inverfely proportional to their diftances; or perhaps it is better to abide by the fenfible law, that *the denfity of air is proportional to the compreffing force*. This law is abundantly fufficient for explaining all the fubordinate phenomena, and for giving us a complete knowledge of the mechanical conftitution of our atmofphere. 218

The height of the air inveftigated from confidering its compreffibility, &c.

219 And, in the firft place, this view of the compreffibility of the air muft give us a very different notion of the height of the atmofphere from what we deduced on a former occafion from our experiments. It is found, that when the air is of the temperature 32° of Fahrenheit's thermometer, and the mercury in the barometer ftands at 30 inches, it will defcend one-tenth of an inch if we take it to a place 87 feet higher. Therefore, if the air were equally denfe and heavy throughout, the height of the atmofphere would be 30×10×87 feet, or 5 miles and 100 yards. But the loofe reafoning adduced on that occafion was enough to fhow us that it muft be much higher; becaufe every ftratum as we afcend muft be fucceffively rarer as it is lefs compreffed by incumbent weight. Not knowing to what degree air expanded when the compreffion was diminifhed, we could not tell the fucceffive diminutions of denfity and confequent augmentation of bulk and height; we could only fay, that feveral atmofpheric appearances indicated a much greater height. Clouds have been feen much higher; but the phenomenon of the twilight is the moft convincing proof of this. There is no doubt that the vifibility of the fky or air is owing to its want of perfect tranfparency, each particle (whether of matter purely aerial or heterogeneous) reflecting a little light.

Plate CCCCIV.

Let *b* (fig. 54.) be the laft particle of illuminated air which can be feen in the horizon by a fpectator at A. This muft be illuminated by a ray SD *b*, touching the earth's furface at fome point D. Now it is a known fact, that the degree of illumination called *twilight* is perceived when the fun is 18° below the horizon of the fpectator, that is, when the angle E *b* S or ACD is 18 degrees; therefore *b* C is the fecant of 9 degrees (it is lefs, viz. about 8¼ degrees, on account of refraction). We know the earth's radius to be about 3970 miles: hence we conclude *b* B to be about 45 miles; nay, a very fenfible illumination is perceptible much farther from the fun's place than this, perhaps twice as far, and the air is fufficiently denfe for reflecting a fenfible light at the height of nearly 200 miles. 220

Experiment fixes no limit to the air's expanfibility.

221 We have now feen that air is prodigioufly expanfible. None of our experiments have diftinctly fhown us any limit. But it does not follow that it is expanfible without end; nor is this at all likely. It is much more probable that there is a certain diftance of the parts in which they no longer repel each other; and this would be the diftance at which they would arrange themfelves if they were not heavy. But at the very fummit of the atmofphere they will be a very fmall matter nearer to each other, on account of their gravitation to the earth. Till we know precifely the law of this mutual repulfion, we cannot fay what is the height of the atmofphere.

But if the air be an elaftic fluid whofe denfity is always

Height of the Atmoſphere.

ways proportionable to the compreſſing force, we can tell what is its denſity at any height above the ſurface of the earth: and we can compare the denſity ſo calcu-
222 lated with the denſity diſcovered by obſervation: for this laſt is meaſured by the height at which it ſupports mercury in the barometer. This is the direct meaſure of the preſſure of the external air; and as we know the law of gravitation, we can tell what would be the preſſure of air having the calculated denſity in all its parts.

Earther obſervations on, and inveſtigation of, the height of the atmoſphere.

223 Let us therefore ſuppoſe a priſmatic or cylindric column of air reaching to the top of the atmoſphere. Let this be divided into an indefinite number of ſtrata of very ſmall and equal depths or thickneſs; and let us, for greater ſimplicity, ſuppoſe at firſt that a particle of air is of the ſame weight at all diſtances from the centre of the earth.

224 The abſolute weight of any one of theſe ſtrata will on theſe conditions be proportional to the number of particles or the gravity of air contained in it; and ſince the depth of each ſtratum is the ſame, this quantity of air will evidently be as the denſity of the ſtratum: but the denſity of any ſtratum is as the compreſſing force; that is, as the preſſure of the ſtrata above it; that is, as their weight; that is, as their quantity of matter—therefore the quantity of air in each ſtratum is proportional to the quantity of air above it; but the quantity in each ſtratum is the difference between the column incumbent on its bottom and on its top: theſe differences are therefore proportional to the quantities of which they are the differences. But when there is a ſeries of quantities which are proportional to their own differences, both the quantities and their differences are in continual or geometrical progreſſion: for let a, b, c, be three ſuch quantities that

$b : c = a - b : b - c$, then, by altern.
$b : a - b = c : b - c$ and by compoſ.
$b : a = c : b$
and $a : b = b : c$

therefore the denſities of theſe ſtrata decreaſe in a geometrical progreſſion; that is, when the elevations above the centre or ſurface of the earth increaſe, or their depths under the top of the atmoſphere decreaſe, in an arithmetical progreſſion, the denſities decreaſe in a geometrical progreſſion.

225 Plate CCCCIV. Let ARQ (fig. 55.) repreſent the ſection of the earth by a plane through its centre O, and let m OAM be a vertical line, and AE perpendicular to OA will be a horizontal line through A, a point on the earth's ſurface. Let AE be taken to repreſent the denſity of the air at A; and let DH, parallel to AE, be taken to AE as the denſity at D is to the denſity at A: it is evident, that if a logiſtic or logarithmic curve EHN be drawn, having AN for its axis, and paſſing through the points E and H, the denſity of the air at any other point C, in this vertical line, will be repreſented by CG, the ordinate to the curve in that point: for it is the property of this curve, that if portions AB, AC, AD, of its axis be taken in arithmetical progreſſion, the ordinates AE, BF, CG, DH, will be in geometrical progreſſion.

226 It is another fundamental property of this curve, that if EK or HS touch the curve in E or H, the ſubtangent AK or DS is a conſtant quantity.

And a third fundamental property is, that the infinitely extended area MAEN is equal to the rectangle KAEL of the ordinate and ſubtangent; and, in like manner, the area MDHN is equal to SD×DH, or to KA×DH; conſequently the area lying beyond any ordinate is proportional to that ordinate. 227

Theſe geometrical properties of this curve are all analogous to the chief circumſtances in the conſtitution of the atmoſphere, on the ſuppoſition of equal gravity. 228 The area MCGN repreſents the whole quantity of aereal matter which is above C: for CG is the denſity at C, and CD is the thickneſs of the ſtratum between C and D; and therefore CGHD will be as the quantity of matter or air in it; and in like manner of all the others, and of their ſums, or the whole area MCGN: and as each ordinate is proportional to the area above it, ſo each denſity, and the quantity of air in each ſtratum, is proportional to the quantity of air above it; and as the whole area MAEN is equal to the rectangle KAEL, ſo the whole air of variable denſity above A might be contained in a column KA, if, inſtead of being compreſſed by its own weight, it were without weight, and compreſſed by an external force equal to the preſſure of the air at the ſurface of the earth. In this caſe, it would be of the uniform denſity AE, which it has at the ſurface of the earth, making what we have repeatedly called the homogeneous atmoſphere.

Hence we derive this important circumſtance, that the height of the homogeneous atmoſphere is the ſubtangent of that curve whoſe ordinates are as the denſities of the air at different heights, on the ſuppoſition of equal gravity. This curve may with propriety be called the ATMOSPHERICAL LOGARITHMIC: and as the different logarithmics are all characteriſed by their ſubtangents, it is of importance to determine this one. 229

It may be done by comparing the denſities of mercury and air. For a column of air of uniform denſity, reaching to the top of the homogeneous atmoſphere, is in equilibrio with the mercury in the barometer. Now it is found, by the beſt experiments, that when mercury and air are of the temperature 32° of Fahrenheit's thermometer, and the barometer ſtands at 30 inches, the mercury is nearly 10440 times denſer than air. Therefore the height of the homogeneous atmoſphere is 10440 times 30 inches, or 26100 feet, or 8700 yards, or 4350 fathoms, or 5 miles wanting 100 yards.

Or it may be found by obſervations on the barometer. 230 It is found, that when the mercury and air are of the above temperature, and the barometer on the ſea-ſhore ſtands at 30 inches, if we carry it to a place 884 feet higher it will fall to 29 inches. Now, in all logarithmic curves having equal ordinates, the portions of the axes intercepted between the correſponding pairs of ordinates are proportional to the ſubtangents. And the ſubtangents of the curve belonging to our common tables is 0,4342945, and the difference of the logarithms of 30 and 29 (which is the portion of the axis intercepted between the ordinates 30 and 29), or 0,0147233, is to 0,4342945 as 883 is to 26058 feet, or 8686 yards, or 4343 fathoms, or 5 miles wanting 14 yards. This determination is 14 yards leſs than the other, and it is uncertain which is the moſt exact. It is extremely difficult to meaſure the reſpective denſities of mercury and air; and in meaſuring the elevation which produces

duces a fall of one inch in the barometer, an error of $\frac{1}{10}$ of an inch would produce all the difference. We prefer the laſt, as depending on fewer circumſtances.

But all this inveſtigation proceeds on the ſuppoſition of equal gravity, whereas we know that the weight of a particle of air decreaſes as the ſquare of its diſtance from the centre of the earth increaſes. In order, therefore, that a ſuperior ſtratum may produce an equal preſſure at the ſurface of the earth, it muſt be denſer, becauſe a particle of it gravitates leſs. The denſity, therefore, at equal elevations, muſt be greater than on the ſuppoſition of equal gravity, and the law of diminution of denſity muſt be different.

$$\text{Make } OD : OA = OA : Od;$$
$$OC : OA = OA : Oc;$$
$$OB : OA = OA : Ob, \&c;$$

ſo that Od, Oc, Ob, OA, may be reciprocals to OD, OC, OB, OA; and through the points A, b, c, d, draw the perpendiculars AE, bf, cg, dh, making them proportional to the denſities in A, B, C, D: and let us ſuppoſe CD to be exceedingly ſmall, ſo that the denſity may be ſuppoſed uniform through the whole ſtratum. Thus we have

$$OD \times Od = OA^2, = OC \times Oc$$
$$\text{and } Oc : Od = OD : OC;$$
$$\text{and } Oc : Oc - Od = OD : OD - OC,$$
$$\text{or } Oc : cd = OD : DC;$$
$$\text{and } cd : CD = Oc : OD;$$

or, becauſe OC and OD are ultimately in the ratio of equality, we have

$$cd : CD = Oc : OC = OA^2 : OC^2,$$

$$\text{and } cd = CD \times \frac{OA^2}{OC^2}, \text{ and } cd \times cg = CD \times cg \times \frac{OA^2}{OC^2};$$

but $CD \times cg \times \frac{OA^2}{OC^2}$ is as the preſſure at C ariſing from the abſolute weight of the ſtratum CD. For this weight is as the bulk, as the denſity, and as the gravitation of each particle jointly. Now CD expreſſes the bulk, cg the denſity, and $\frac{OA^2}{OC^2}$ the gravitation of each particle. Therefore, $cd \times cg$ is as the preſſure on C ariſing from the weight of the ſtratum DC; but $cd \times cg$ is evidently the element of the curvilinear area AmnE, formed by the curve E$fghn$ and the ordinates AE, bf, cg, ah, &c. mn. Therefore the ſum of all the elements, ſuch as $cdhg$, that is, the area $cmng$ below cg, will be as the *whole* preſſure on C, ariſing from the gravitation of all the air above it; but, by the nature of air, this whole preſſure is as the denſity which it produces, that is, as cg. Therefore the curve Egn is of ſuch a nature that the area lying below or beyond any ordinate cg is proportional to that ordinate. This is the property of the logarithmic curve, and Egn is a logarithmic curve.

232 But farther, this curve is the ſame with EGN. For let B continually approach to A, and ultimately coincide with it. It is evident that the ultimate ratio of BA to Ab, and of BF to bf, is that of equality; and if EFK, Efk, be drawn, they will contain equal angles with the ordinate AE, and will cut off equal ſubtangents AK, Ak. The curves EGN, Egn are therefore the ſame, but in oppoſite poſitions.

233 Laſtly, if OA, Ob, Oc, Od, &c. be taken in arithmetical progreſſion decreaſing, their reciprocals OA, OB, OC, OD, &c. will be in harmonical progreſſion increaſing, as is well known: but, from the nature of the logarithmic curve, when OA, Ob, Oc, Od, &c. are in arithmetical progreſſion, the ordinates AE, bf, cg, dh, &c. are in geometrical progreſſion. Therefore when OA, OB, OC, OD, &c. are in harmonical progreſſion, the denſities of the air at A, B, C, D, &c. are in geometrical progreſſion; and thus may the denſity of the air at all elevations be diſcovered. Thus to find the denſity of the air at K the top of the homogeneous atmoſphere, make OK : OA = OA : OL, and draw the ordinate LT, LT is the denſity at K. Height of the Atmoſphere.

The celebrated Dr Halley was the firſt who obſerved the relation between the denſity of the air and the ordinates of the logarithmic curve, or common logarithms. This he did on the ſuppoſition of equal gravity; and his diſcovery is acknowledged by Sir Iſaac Newton in *Princip.* ii. *prop.* 22. *ſchol.* Halley's diſſertation on the ſubject is in n° 185 of the Phil. Tranſ. Newton, with his uſual ſagacity, extended the ſame relation to the true ſtate of the caſe, where gravity is as the ſquare of the diſtance inverſely; and ſhowed that when the diſtances from the earth's centre are in harmonic progreſſion, the denſities are in geometric progreſſion. He ſhows indeed, in general, what progreſſion of the diſtance, on any ſuppoſition of gravity, will produce a geometrical progreſſion of the denſities, ſo as to obtain a ſet of lines OA, Ob, Oc, Od, &c. which will be logarithms of the denſities. The ſubject was afterwards treated in a more familiar manner by Cotes in his *Hydroſt. Lect.* and in his *Harmonia Menſurarum;* alſo by Dr Brooke Taylor, *Meth. Increment;* Wolf in his *Aerometria;* Herman in his *Phoronomia;* &c. &c. and lately by Horſley, Phil. Tranſ. tom. lxiv.

An important corollary is deducible from theſe principles, viz. that the air has a finite denſity at an infinite diſtance from the centre of the earth, namely, ſuch as will be repreſented by the ordinate OP drawn through the centre. It may be objected to this concluſion, that it would infer an infinity of matter in the univerſe, and that it is inconſiſtent with the phenomena of the planetary motions, which appear to be performed in a ſpace void of all reſiſtance, and therefore of all matter. But this fluid muſt be ſo rare at great diſtances, that the reſiſtance will be inſenſible, even though the retardation occaſioned by it has been accumulated for ages. Even at the very moderate diſtance of 500 miles, the rarity is ſo great that a cubic inch of common air expanded to that degree would occupy a ſphere equal to the orbit of Saturn; and the whole retardation which this planet would ſuſtain after ſome millions of years would not exceed what would be occaſioned by its meeting one bit of matter of half a grain weight. 234 The air has a finite denſity at an infinite diſtance from the centre of the earth.

This being the caſe, it is not unreaſonable to ſuppoſe the viſible univerſe occupied by air, which, by its gravitation, will accumulate itſelf round every body in it, in a proportion depending on their quantities of matter, the larger bodies attracting more of it than the ſmaller ones, and thus forming an atmoſphere about each. And many appearances warrant this ſuppoſition. Jupiter, Mars, Saturn, and Venus, are evidently ſurrounded by atmoſpheres. The conſtitution of theſe atmoſpheres may differ exceedingly from other cauſes. If the planet has nothing on its ſurface which can be diſſolved by

Atmospheres of the other Planets, &c.

by the air or volatilised by heat, the atmosphere will be continually clear and transparent, like that of the moon.

235 The atmosphere of Mars,

Mars has an atmosphere which appears precisely like our own, carrying clouds, or depositing snows: for when, by the obliquity of his axis to the plane of his ecliptic, he turns his north pole towards the sun, it is observed to be occupied by a broad white spot. As the summer of that region advances, this spot gradually wastes, and sometimes vanishes, and then the south pole comes in sight, surrounded in like manner with a white spot, which undergoes similar changes. This is precisely the appearance which the snowy circumpolar regions of this earth will exhibit to an astronomer on Mars. It may not, however, be snow that we see; thick clouds will have the same appearances.

236 Of Jupiter,

The atmosphere of the planet Jupiter is also very similar to our own. It is diversified by streaks or belts parallel to his equator, which frequently change their appearance and dimensions, in the same manner as those tracks of similar sky which belong to different regions of this globe. There is a certain kind of weather that more properly belongs to a particular climate than to any other. This is nothing but a certain general state of the atmosphere which is prevalent there, though with considerable variations. This must appear to a spectator in the moon like a streak spread over that climate, distinguishing it from others. But the most remarkable similarity is in the motion of the clouds on Jupiter. They have plainly a motion from east to west relative to the body of the planet: for there is a remarkable spot on the surface of the planet, which is observed to turn round the axis in 9h. 51′ 16″; and there frequently appear variable and perishing spots in the belts, which sometimes last for several revolutions. These are observed to circulate in 9. 55. 05. These numbers are the results of a long series of observations by Dr Herschel. This plainly indicates a general current of the clouds westward, precisely similar to what a spectator in the moon must observe in our atmosphere arising from the trade-winds. Mr Schroeter has made the atmosphere of Jupiter a study for many years; and deduces from his observations that the motion of the variable spots is subject to great variations, but is always from east to west. This indicates variable winds.

237 Of Venus,

The atmosphere of Venus appears also to be like ours, loaded with vapours, and in a state of continual change of absorption and precipitation. About the middle of last century the surface of Venus was pretty distinctly seen for many years chequered with irregular spots, which are described by Campani, Bianchini, and other astronomers in the south of Europe, and also by Cassini at Paris, and Hooke and Townley in England. But the spots became gradually more faint and indistinct; and, for near a century, have disappeared. The whole surface appears now of one uniform brilliant white. The atmosphere is probably filled with a reflecting vapour, thinly diffused through it, like water faintly tinged with milk. A great depth of this must appear as white as a small depth of milk itself; and it appears to be of a *very great* depth, and to be refractive like our air. For Dr Herschel has observed, by the help of his fine telescopes, that the illuminated part of Venus is considerably more than a hemisphere, and that the light dies gradually away to the bounding margin. This is the very appearance that the earth would make if furnished with such an atmosphere. The boundary of illumination would have a penumbra reaching about nine degrees beyond it. If this be the constitution of the atmosphere of Venus, she may be inhabited by beings like ourselves. They would not be dazzled by the intolerable splendor of a sun four times as big and as bright, and sixteen times more glaring, than ours; for they would seldom or never see him, but instead of him an uniformly bright and white sky. They would probably never see a star or planet, unless the dog-star and Mercury; and perhaps the earth might pierce through the bright haze which surrounds their planet. For the same reason the inhabitants would not perhaps be incommoded by the sun's heat. It is indeed a very questionable thing, whether the sun would cause any heat, even here, if it were not for the chemical action of his rays on our air. This is rendered not improbable by the intense cold felt on the tops of the highest mountains, in the clearest air, and even under a vertical sun in the torrid zone.

238 And of comets.

The atmosphere of comets seems of a nature totally different. This seems to be of inconceivable rarity, even when it reflects a very sensible light. The tail is always turned nearly away from the sun. It is thought that this is by the impulse of the solar rays. If this be the case, we think it might be discovered by the aberration and the refraction of the light by which we see the tail: for this light must come to our eye with a much smaller velocity than the sun's light, if it be reflected by repulsive or elastic forces, which there is every reason in the world to believe; and therefore the velocity of the reflected light will be diminished by all the velocity communicated to the reflecting particles. This is almost inconceivably great. The comet of 1680 went half round the sun in ten hours, and had a tail at least a hundred millions of miles long, which turned round at the same time, keeping nearly in the direction opposite to the sun. The velocity necessary for this is prodigious, approaching to that of light. And perhaps the tail extends much farther than we see it, but is visible only as far as the velocity with which its particles recede from the sun is less than a certain quantity, namely, what would leave a sufficient velocity for the reflected light to enable it to affect our eyes. And it may be demonstrated, that although the real form of the visible tail is concave on the anterior side to which the comet is moving, it may appear convex on that side, in consequence of the very great aberration of the light by which the remote parts are seen. All this may be discovered by properly contrived observations; and the conjecture merits attention. But of this digression there is enough; and we return to our subject, the constitution of our air.

239 The barometer used in taking heights.

We have shown how to determine *à priori* the density of the air at different elevations above the surface of the earth. But the densities may be discovered in all accessible elevations by experiments; namely, by observing the heights of the mercury in the barometer. This is a direct measure of the pressure of the incumbent atmosphere; and this is proportional to the density which it produces.

240 Therefore, by means of the relation subsisting between the densities and the elevations, we can discover the elevations by observations made on the densities by means of

meter. of the barometer; and thus we may meafure elevations by means of the barometer; and, with very little trouble, take the level of any extenfive track of country. Of this we have an illuftrious example in the fection which the Abbé Chappe D'Auteroche has given of the whole country between Breft and Ekaterinenburgh in Siberia. This is a fubject which deferves a minute confideration: we fhall therefore prefent it under a very fimple and familiar form; and trace the method through its various fteps of improvement by De Luc, Roy, Shuckbourgh, &c.

241 Explanation of its &c. We have already obferved oftener than once, that if the mercury in the barometer ftands at 30 inches, and if the air and mercury be of the temperature 32° in Fahrenheit's thermometer, a column of air 87 feet thick has the fame weight with a column of mercury $\frac{1}{10}$ of an inch thick. Therefore, if we carry the barometer to a higher place, fo that the mercury finks to 29.9, we have afcended 87 feet. Now, fuppofe we carry it ftill higher, and that the mercury ftands at 29.8; it is required to know what height we have now got to? We have evidently afcended through another ftratum of equal weight with the former: but it muft be of greater thicknefs, becaufe the air in it is rarer, being lefs compreffed. We may call the denfity of the firft ftratum 300, meafuring the denfity by the number of tenths of an inch of mercury which its elafticity proportional to its denfity enables it to fupport. For the fame reafon, the denfity of the fecond ftratum muft be 299: but when the weights are equal, the bulks are inverfely as the denfities; and when the bafes of the ftrata are equal, the bulks are as the thickneffes. Therefore, to obtain the thicknefs of this fecond ftratum, fay 299:300=87:87,29; and this fourth term is the thicknefs of the fecond ftratum, and we have afcended in all 174,29 feet. In like manner we may rife till the barometer fhows the denfity to be 298: then fay, 298 : 30=87 : 87,584 for the thicknefs of the third ftratum, and 261,875 or 261$\frac{7}{8}$ for the whole afcent; and we may proceed in the fame way for any number of mercurial heights, and make a table of the correfponding elements as follows: where the firft column is the height of the mercury in the barometer, the fecond column is the thicknefs of the ftratum, or the elevation above the preceding ftation; and the third column is the whole elevation above the firft ftation.

Bar.	Strat.	Elev.
30	00,000	00,000
29,9	87,000	87,000
29,8	87,291	174,291
29,7	87,584	261,875
29,6	87,879	349,754
29,5	88,176	437,930
29,4	88,475	526,405
29,3	88,776	615,181
29,2	89,079	704,260
29,1	89,384	793,644
29	89,691	883,335

242 Having done this, we can now meafure any elevation within the limits of our table, in this manner.

Obferve the barometer at the lower and at the upper ftations, and write down the correfponding elevations. Subtract the one from the other, and the remainder is the height required. Thus fuppofe that at the lower ftation the mercurial height was 29,8, and that at the upper ftation it was 29,1. Taking heights.

29,1	793,644
29,8	174,291
	619,353 = Elevation.

We may do the fame thing with tolerable accuracy without the table, by taking the medium m of the mercurial heights, and their difference d in tenths of an inch; and then fay, as m to 300, fo is $87d$ to the height required h: or $h=\frac{300\times 87d}{m}=\frac{26100d}{m}$. Thus, in the foregoing example, m is 294,5, and d is =7; and therefore $h=\frac{7\times 26100}{294,5}=620,4$, differing only one foot from the former value.

Either of thefe methods is fufficiently accurate for moft purpofes, and even in very great elevations will not produce any error of confequence: the whole error of the elevation 883 feet 4 inches, which is the extent of the above table, is only $\frac{1}{2}$ of an inch.

But we need not confine ourfelves to methods of approximation, when we have an accurate and fcientific method that is equally eafy. We have feen that, upon the fuppofition of equal gravity, the denfities of the air are as the ordinates of a logarithmic curve, having the line of elevations for its axis. We have alfo feen that, in the true theory of gravity, if the diftances from the centre of the earth increafe in a harmonic progreffion, the logarithm of the denfities will decreafe in an arithmetical progreffion; but if the greateft elevation above the furface be but a few miles, this harmonic progreffion will hardly differ from an arithmetical one. Thus, if Ab, Ac, Ad, are 1, 2, and 3 miles, we fhall find that the correfponding elevations AB, AC, AD are fenfibly in arithmetical progreffion alfo: for the earth's radius AC is nearly 4000 miles. Hence it plainly follows, that BC—AB is $\frac{1}{4000\times 4001}$, or $\frac{1}{16004000}$ of a mile, or $\frac{1}{250}$ of an inch; a quantity quite infignificant. We may therefore affirm without hefitation, that in all acceffible places, the elevations increafe in an arithmetical progreffion, while the denfities decreafe in a geometrical progreffion. Therefore the ordinates are proportional to the numbers which are taken to meafure the denfities, and the portions of the axis are proportional to the logarithms of thefe numbers. It follows, therefore, that we may take fuch a fcale for meafuring the denfities that the logarithms of the numbers of this fcale fhall be the very portions of the axis; that is, of the vertical line in feet, yards, fathoms, or what meafure we pleafe: and we may, on the other hand, choofe fuch a fcale for meafuring our elevations, that the logarithms of our fcale of denfities fhall be parts of this fcale of elevations; and we may find either of thefe fcales fcientifically. For it is a known property of the logarithmic curves, that when the ordinates are the fame, the intercepted portions of the abfciffæ are proportional to their fubtangents. Now we know the fubtangent of the atmofpherical logarithmic: it is the height of the homogeneous atmofphere in any meafure we pleafe, fuppofe fathoms: we find this height by comparing the gravities of air and mercury, when both

243 (margin number beside "But we need not confine")

Barometer. both are of some determined density. Thus, in the temperature of 32° of Fahrenheit's thermometer, when the barometer stands at 30 inches, it is known (by many experiments) that mercury is 10423,068 times heavier than air; therefore the height of the balancing column of homogeneous air will be 10423,068 times 30 inches; that is, 4342,945 English fathoms. Again, it is known that the subtangent of our common logarithmic tables, where 1 is the logarithm of the number 10, is 0,4342945. Therefore the number 0,4342945 is to the difference D of the logarithms of any two barometric heights as 4342,945 fathoms are to the fathoms F contained in the portion of the axis of the atmospherical logarithmic, which is intercepted between the ordinates equal to these barometrical heights; or that $0,4342945 : D = 4342,945 : F$, and $0,4342,945 : 4342,945 = D : F$; but 0,4342945 is the ten-thousandth part of 4342,945, and therefore D is the ten-thousandth part of F.

244 And thus it happens, by mere chance, that the logarithms of the densities, measured by the inches of mercury which their elasticity supports in the barometer, are just the ten-thousandth part of the fathoms contained in the corresponding portions of the axis of the atmospherical logarithmic. Therefore, if we multiply our common logarithms by 10000, they will express the fathoms of the axis of the atmospherical logarithmic; nothing is more easily done. Our logarithms contain what is called the index or characteristic, which is an integer and a number of decimal places. Let us just remove the integer-place four figures to the right hand: thus the logarithm of 60 is 1.7781513, which is one integer and $\frac{7781513}{10000000}$. Multiply this by 10,000, and we obtain $\frac{513}{1001}$ 17781,513, or 17781 $\frac{513}{1000}$.

245 The practical application of all this reasoning is obvious and easy: observe the heights of the mercury in the barometer at the upper and lower stations in inches and decimals; take the logarithms of these, and subtract the one from the other: the difference between them (accounting the four first decimal figures as integers) is the difference of elevation of fathoms.

Example.

Merc. Height at the lower station	29,8	1.4742163
upper station	29,1	1.4638930
Diff. of Log. ×10000		0.0103,233

or 103 fathoms and $\frac{233}{1000}$ of a fathom, which is 619,392 feet, or 619 feet $4\frac{3}{4}$ inches; differing from the approximated value formerly found about $\frac{1}{2}$ an inch.

246 This method of measuring heights now much improved. Such is the general nature of the barometric measurement of heights first suggested by Dr Halley; and it has been verified by numberless comparisons of the heights calculated in this way with the same height measured geometrically. It was indeed in this way that the precise specific gravity of air and mercury was most accurately determined; namely, by observing, that when the temperature of air and mercury was 32, the difference of the logarithms of the mercurial heights were precisely the fathoms of elevation. But it requires many corrections to adjust this method to the circumstances of the case; and it was not till very lately that it has been so far adjusted to them as to become useful. We are chiefly indebted to Mr de Luc for the improvements. The great elevations in Switzerland enabled him to make an immense number of observations, in almost every variety of circumstances. Sir George Shuckbourgh also made a great number with most accurate instruments in much greater elevations, in the same country; and he made many chamber experiments for determining the laws of variation in the subordinate circumstances. General Roy also made many to the same purpose. And to these two gentlemen we are chiefly obliged for the corrections which are now generally adopted.

247 It depends on the specific gravity of air and mercury. It is easy to perceive that the method, as already expressed, cannot apply to every case: it depends on the specific gravity of air and mercury, combined with the supposition that this is affected *only by a change of pressure*. But since all bodies are expanded by heat, and as there is no reason to suppose that they are equally expanded by it, it follows that a change of temperature will change the relative gravity of mercury and air, even although both suffer the same change of temperature: and since the air may be warmed or cooled when the mercury is not, or may change its temperature independent of it, we may expect still greater variations of specific gravity.

The general effect of an augmentation of the specific gravity of the mercury must be to increase the subtangent of the atmospherical logarithmic; in which case the logarithms of the densities, as measured by inches of mercury, will express measures that are greater than fathoms in the same proportion that the subtangent is increased; or, when the air is more expanded than the mercury, it will require a greater height of homogeneous atmosphere to balance 30 inches of mercury, and a given fall of mercury will then correspond to a thicker stratum of air.

In order, therefore, to perfect this method, we must learn by experiment how much mercury expands by an increase of temperature; we must also learn how much the air expands by the same, or any change of temperature; and how much its elasticity is affected by it. Both these circumstances must be considered in the case of air; for it might happen that the elasticity of the air is not so much affected by heat as its bulk is.

It will, therefore, be proper to state in this place the experiments which have been made for ascertaining these two expansions.

248 General Roy's experiments on the expansion of mercury. The most accurate, and the best adapted experiments for ascertaining the expansion of mercury, are those of General Roy, published in the 67th volume of the Philosophical Transactions. He exposed 30 inches of mercury, actually supported by the atmosphere in a barometer, in a nice apparatus, by which it could be made of one uniform temperature through its whole length; and he noted the expansion of it in decimals of an inch. These are contained in the following table; where the first column expresses the temperature by Fahrenheit's thermometer, the second column expresses the bulk of the mercury, and the third column the expansion of an inch of mercury for an increase of one degree in the adjoining temperatures.

TABLE

Table A.

Temp.	Bulk of ☿.	Expan. for 1°
212°	30,5117	0,0000763
202	30,4888	0,0000787
192	30,4652	0,0000810
182	30,4409	0,0000833
172	30,4159	0,0000857
162	30,3902	0,0000880
152	30,3638	0,0000903
142	30,3367	0,0000923
132	30,3090	0,0000943
122	30.2807	0,0000963
112	30,2518	0,0000983
102	30,2223	0,0001003
92	30,1922	0,0001023
82	30,1615	0,0001043
72	30,1302	0,0001063
62	30,0984	0,0001077
52	30,0661	0,0001093
42	30,0333	0,0001110
32	30,0000	0,0001127
22	29,9662	0,0001143
12	29,9319	0,0001160
2	29,8971	0,0000177
0	29,8901	

249 This table gives rise to some reflections. The scale of the thermometer is constructed on the supposition that the successive degrees of heat are measured by equal increments of bulk in the mercury of the thermometer. How comes it, therefore, that this is not accompanied by equal increments of bulk in the mercury of the column, but that the corresponding expansions of this column do continually diminish? General Roy attributes this to the gradual detachment of elastic matter from the mercury by heat, which presses on the top of the column, and therefore shortens it. He applied a boiling heat to the vacuum a-top, without producing any farther depression; a proof that the barometer had been carefully filled. It had indeed been boiled through its whole length. He had attempted to measure the mercurial expansion in the usual way, by filling 30 inches of the tube with boiled mercury, and exposing it to the heat with the open end uppermost. But here it is evident that the expansion of the tube, and its solid contents, must be taken into the account. The expansion of the tube was found so exceedingly irregular, and so incapable of being determined with precision for the tubes which were to be employed, that he was obliged to have recourse to the method with the real barometer. In this no regard was necessary to any circumstance but the perpendicular height. There was, besides, a propriety in examining the mercury in the very condition in which it was used for measuring the pressure of the atmosphere; because whatever complication there was in the results, it was the same in the barometer in actual use.

250 The most obvious manner of applying these experiments on the expansion of mercury to our purpose, is to reduce the observed height of the mercury to what it would have been if it were of the temperature 32. Thus, suppose that the observed mercurial height is 29,2, and that the temperature of the mercury is 72° make 30,1302 : 30=29,2 : 29,0738. This will be the true measure of the density of the air of the standard temperature. In order that we may obtain the exact temperature of the mercury, it is proper that the observation be made by means of a thermometer attached to the barometer-frame, so as to warm and cool along with it.

Taking heights.

Or, this may be done without the help of a table, 251 and with sufficient accuracy, from the circumstance that the expansion of an inch of mercury for one degree diminishes very nearly $\frac{1}{500}$th part in each succeeding degree. If therefore we take from the expansion at 32° its thousandth part for each degree of any range above it, we obtain a mean rate of expansion for that range. If the observed temperature of the mercury is below 32°, we must *add* this correction to obtain the mean expansion. This rule will be made more exact if we suppose the expansion at 32° to be =0,0001127. Then multiply the observed mercurial height by this expansion, and we obtain the correction, to be subtracted or added according as the temperature of the mercury was above or below 32°. Thus to abide by the former example of 72°. This exceeds 32° by 40: therefore take 40 from 0,0001127, and we have 0,0001087 for the medium expansion for that range. Multiply this by 40, and we have the whole expansion of one inch of mercury, =0,004348. Multiply the inches of mercurial height, viz. 29,2, by this expansion, and we have for the correction 0,12696; which being subtracted from the observed height leaves 29,07304, differing from the accurate quantity less than the thousandth part of an inch. This rule is very easily kept in the memory, and supersedes the use of a table.

This correction may be made with all necessary ex- 252 actness by a rule still more simple; namely, by multiplying the observed height of the mercury by the difference of its temperature from 32°, and cutting off four cyphers before the decimals of the mercurial height. This will seldom err $\frac{1}{100}$ of an inch. We even believe that it is the most exact method within the range of temperatures that can be expected to occur in measuring heights: for it appears, by comparing many experiments and observations, that General Roy's measure of the mercurial expansion is too great, and that the expansion of an inch of mercury between 20° and 70 of Fahrenheit's thermometer does not exceed 0,000102 *per* degree. Having thus corrected the observed mercurial heights by reducing them to what they would have been if the mercury had been of the standard temperature, the logarithms of the corrected heights are taken, and their difference, multiplied by 10000, will give the difference of elevations in English fathoms.

There is another way of applying this correction, 253 fully more expeditious and equally accurate. The difference of the logarithms of the mercurial heights is the measure of the ratio of those heights. In like manner the difference of the logarithms of the observed and corrected heights at any station is the measure of the ratio of those heights. Therefore this last difference of the logarithms is the measure of the correction of this ratio. Now the observed height is to the corrected height nearly as 1 to 1,000102. The logarithm of this ratio, or the difference of the logarithms of 1 and 1,000102, is 0,0000444. This is the correction for each degree that the temperature of the mercury differs from 32. Therefore multiply 0,0000444 by the difference of the mercurial temperatures from 32, and the products

Barometer.

products will be the corrections of the respective logarithms.

254 But there is still an easier way of applying the logarithmic correction. If both the mercurial temperatures are the same, the differences of their logarithms will be the same, although each may be a good deal above or below the standard temperature, if the expansion be very nearly equable. The correction will be necessary only when the temperatures at the two stations are different, and will be proportional to this difference. Therefore, if the difference of the mercurial temperatures be multiplied by 0,0000444, the product will be the correction to be made on the difference of the logarithms of the mercurial heights.

But farther, since the differences of the logarithms of the mercurial heights are also the differences of elevation in English fathoms, it follows that the correction is also a difference of elevation in English fathoms, or that the correction for one degree of difference of mercurial temperature is $\frac{444}{1000}$ of a fathom, or 32 inches, or 2 feet 8 inches.

This correction of 2.8 for every degree of difference of temperature must be subtracted from the elevation found by the general rate, when the mercury at the upper station is colder than that at the lower. For when this is the case, the mercurial column at the upper station will appear too short, the pressure of the atmosphere too small, and therefore the elevation in the atmosphere will appear greater than it really is.

255 Therefore the rule for this correction will be to multiply 0,0000444 by the degrees of difference between the mercurial temperatures at the two stations, and to add or subtract the product from the elevation found by the general rule, according as the mercury at the upper station is hotter or colder than that at the lower.

256 If the experiments of General Roy on the expansion of the mercury in a real barometer be thought most deserving of attention, and the expansion be considered as variable, the logarithmic difference corresponding to this expansion for the *mean* temperature of the two barometers may be taken. These logarithmic differences are contained in the following table, which is carried as far as 112°, beyond which it is not probable that any observations will be made. The number for each temperature is the difference between the logarithms of 30 inches, of the temperature 32, and of 30 inches expanded by that temperature.

TABLE B.

Temp.	Log. diff.	Dec. of Fath.	Ft. In.
112°			
	0.0000427	,427	2.7
102			
	0.0000436	,436	2.7
92			
	0.0000444	,444	2.8
82			
	0.0000453	,453	2.9
72			
	0.0000460	,460	2.9
62			
	0.0000468	,468	2.10
52			
	0.0000475	,475	2.10
42			
	0.0000482	,482	2.11
32			
	0.0000489	,489	2.11
22			
	0.0000497	,497	3.0
12			
	0.0000504	,504	3.0
0			

257 The temperature of the air must also be attended to.

It is also necessary to attend to the temperature of the air; and the change that is produced by heat in its density is of much greater consequence than that of the mercury. The relative gravity of the two, on which the subtangent of the logarithmic curve depends, and consequently the unit of our scale of elevations, is much more affected by the heat of the air than by the heat of the mercury.

Taking heights.

This adjustment is of incomparably greater difficulty than the former, and we can hardly hope to make it perfect. We shall narrate the chief experiments which have been made on the expansion of air, and deduce from them such rules as appear to be necessary consequences of them, and then notice the circumstances which leave the matter still imperfect.

258 Comparison of mercurial and air thermometer.

General Roy compared a mercurial and an air thermometer, each of which was graduated arithmetically, that is, the units of the scales were equal bulks of mercury, and equal bulks (perhaps different from the former) of air. He found their progress as in the following table.

TABLE C.

Merc.	Diff.	Air.	Diff.
212		212,0	
	20		17,6
192		194,4	
	20		18,2
172		176,2	
	20		18,8
152		157,4	
	20		19,4
132		138,0	
	20		20,0
112		118,0	
	20		20,8
92		97,2	
	20		21,6
72		75,6	
	20		22,6
52		53,0	
	20		21,6
32		31,4	
	20		20,0
12		11,4	

259 It has been established by many experiments that equal increments of heat produce equal increments in the bulk of mercury. The differences of temperature are therefore expressed by the second column, and may be considered as equal; and the numbers of the third column must be allowed to express the same temperatures with those of the first. They *directly* express the *bulks* of the air, and the numbers of the fourth column express the differences of these bulks. These are evidently unequal, and show that common air expands most of all when of the temperature 62 nearly.

260 To determine actual increase of bulk from a known increase of heat.

The next point was to determine what was the *actual* increase of bulk by some known increase of heat. For this purpose he took a tube, having a narrow bore, and a ball at one end. He measured with great care the capacity of both the ball and the tube, and divided the tube into equal spaces which bore a determined proportion to the capacity of the ball. This apparatus was set in a long cylinder filled with frigorific mixtures or with water, which could be uniformly heated up to the boiling temperature, and was accompanied by a nice thermometer. The expansion of the air was measured by means of a column of mercury which rose or sunk in the tube. The tube being of a small bore, the mercury did not drop out of it; and the bore being chosen as equable as possible, this column remained of an uniform length, whatever part of the tube it chanced to occupy. By this contrivance he was able to examine the expansibility of air of various densities. When the column of mercury contained only a single drop or two, the air was nearly of the density of the external air. If he wished to examine the expansion of air twice or thrice as dense, he used a column of 30 or 60 inches long: and to examine the expansion of air that is rarer than the

the external air, he placed the tube with the ball uppermoſt, the open end coming through a hole in the bottom of the veſſel containing the mixtures or water. By this poſition the column of mercury was hanging in the tube, ſupported by the preſſure of the atmoſphere; and the elaſticity of the included air was meaſured by the difference between the ſuſpended column and the common barometer.

The following table contains the expanſion of 1000 parts of air, nearly of the common denſity, by heating it from 0 to 212. The firſt column contains the height of the barometer; the ſecond contains this height augmented by the ſmall column of mercury in the tube of the manometer, and therefore expreſſes the denſity of the air examined; the third contains the total expanſion of 1000 parts; and the fourth contains the expanſion for 1°, ſuppoſing it uniform throughout.

TABLE D.

Barom.	Denſity of Air examined.	Expanſion of 1000 pts by 212°.	Expanſion by 1°.
29,95	31,52	483,89	2,2825
30,07	30,77	482,10	2,2741
29,48	29,90	480,74	2,2676
29,90	30,73	485,86	2,2918
29,96	30,92	489,45	2,3087
29,90	30,55	476,04	2,2455
29,95	30,60	487,55	2,2998
30,07	30,60	482,80	2,2774
29,48	30,00	489,47	2,3087
Mean	30,62	484,21	2,2840

Hence it appears, that the mean expanſion of 1000 parts of air of the denſity 30,62 by one degree of Fahrenheit's thermometer is 2,284, or that 1000 becomes 1002,284.

If this expanſion be ſuppoſed to follow the ſame rate that was obſerved in the compariſon of the mercurial and air thermometer, we ſhall find that the expanſion of a thouſand parts of air for one degree of heat at the different intermediate temperatures will be as in the following table.

TABLE E.

Temp.	Total Expanſion	Expanſion for 1°.
212	484,210	2,0099
192	444,011	2,0080
172	402,452	2,1475
152	359,503	2,2155
132	315,193	2,2840
112	269,513	2,3754
92	222,006	2,4211
82	197,795	2,5124
72	172,671	2,5581
62	147,090	2,6037
52	121,053	2,5124
42	95,929	2,4211
32	71,718	2,3297
22	48,421	2,2383
12	26,038	2,1698
0		

If we would have a mean expanſion for any particular range, as between 12° and 92°, which is the moſt likely to comprehend all the geodætical obſervations, we need only take the difference of the bulks 26,038 and 222,006. = 195,968, and divide this by the interval of temperature 80°, and we obtain 2,4496, or 2,45 for the mean expanſion for 1°. Taking heights.

263 It would perhaps be better to adapt the table to a maſs of 1000 parts of air of the ſtandard temperature 32°; for in its preſent form it ſhows the expanſibility of air originally of the temperature 0. This will be done with ſufficient accuracy by ſaying (for 212°) 1071,718 : 1484,210 = 1000, : 13849, and ſo of the reſt. Thus we ſhall conſtruct the following table of the expanſion of 10,000 parts of air.

TABLE F.

Temp.	Bulk.	Differ.	Expanſ. for 1°.
212	13489	375	18,7
192	13474	387	19,3
172	13087	392	19,6
152	12685	413	20,6
132	12272	426	21,3
112	11846	443	22,1
92	11403	226	22,6
82	11177	235	23,5
72	10942	238	23,8
62	10704	243	24,3
52	10461	235	23,5
42	10226	226	22,6
32	10000	217	21,7
22	9783	209	20,9
12	9574	243	20,2
0	9331		

This will give for the mean expanſion of 1000 parts of air between 12° and 92 = 2,29.

264 Although it cannot happen that in meaſuring the differences of elevation near the earth's ſurface, we ſhall have occaſion to employ air greatly exceeding the common denſity, we may inſert the experiments made by General Roy on ſuch airs. They are expreſſed in the following table; where column firſt contains the denſities meaſured by the inches of mercury that they will ſupport when of the temperature 32°; column ſecond is the expanſion of 1000 parts of ſuch air by being heated from 0 to 212; and column third is the mean expanſion for 1°. General Roy's experiments on air above the common denſity.

TABLE G.

Denſity.	Expanſion for 212.	Expanſ. for 1°.
101,7	451,54	2,130
92,3	423,23	1,996
80,5	412,09	1,944
54,5	439,87	2,075
49,7	443,24	2,091
Mean 75,7	434	2,047

265 We have much more frequent occaſion to operate in air that is rarer than the ordinary ſtate of the ſuperficial atmo- And on air below that denſity.

Barometer

atmosphere. General Roy accordingly made many experiments on such airs. He found in general, that their expansibility by heat was analogous to that of air in its ordinary density, being greatest about the temperature 60°. He found, too, that its expansibility by heat diminished with its density, but he could not determine the law of gradation. When reduced to about $\frac{1}{5}$ of the density of common air, its expansion was as follows.

TABLE H.

Temp.	Bulk.	Difference.	Expanf. for 1°.
212	1141,504	7,075	0,354
192	1134,429	12,264	0,613
172	1122,165	14,150	0,708
152	1108,015	14,151	0,708
132	1093,864	14,228	0,711
112	1079,636	14,937	0,747
92	1064,699	20,911	1,045
72	1043,788	25,943	1,297
52	1017,845	17,845	0,892
32	1000,000		
		Mean expanfion	0,786

266
Air of ordinary density expands most, &c.

From this very extensive and judicious range of experiments, it is evident that the expansibility of air by heat is greatest when the air is about its ordinary density, and that in small densities it is greatly diminished. It appears also, that the law of compression is altered; for in this specimen of the rare air half of the whole expansion happens about the temperature 99°, but in air of ordinary density at 105°. This being the case, we see that the experiments of Mr Amontons, narrated in the Memoirs of the Academy at Paris 1702, &c. are not inconsistent with those more perspicuous experiments of General Roy. Amontons found, that whatever was the density of the air, at least in cases much denser than ordinary air, the change of 180° of temperature increased its elasticity in the same proportion: for he found, that the column of mercury which it supported when of the temperature 50, was increased $\frac{1}{3}$ at the temperature 212. Hence he hastily concluded, that its expansibility was increased in the same proportion; but this by no means follows, unless we are certain that in every temperature the elasticity is proportional to the density. This is a point which still remains undecided; and it merits attention, because if true it establishes a remarkable law concerning the action of heat, which would seem to go to prove that the elasticity of fluids is the property of the matter of fire, which it superinduces on every body with which it combines in the form of vapour.

267
The height which produces a given fall in the barometer, increases with the air's expansion.

After this account of the expansion of air, we see that the height through which we must rise in order to produce a given fall of the mercury in the barometer, or the thickness of the stratum of air equiponderant with a tenth of an inch of mercury, must increase with the expansion of air; and that if $\frac{2,29}{1000}$ be the expansion for one degree, we must multiply the excess of the temperature of the air above 32° by 0,00229, and multiply the product by 87, in order to obtain the thickness of the stratum where the barometer stands at 30 inches; or whatever be the elevation indicated by the difference of the barometrical heights, upon the supposition that the air is of the temperature 32°, we must multiply this by 0,00229 for every degree that the air is warmer or colder than 32. The product must be added to the elevation in the first case, and subtracted in the latter.

268

Sir George Shuckbourgh deduces 0,0024 from his experiments as the mean expansion of air in the ordinary cases: and this is probably nearer the truth; because General Roy's experiments were made on air which was freer from damp than the ordinary air in the fields; and it appears from his experiments, that a very minute quantity of damp increases its expansibility by heat in a prodigious degree.

269
Difficulty in this mode of measuring heights.

The great difficulty is how to apply this correction; or rather, how to determine the temperature of the air in those extensive and deep strata in which the elevations are measured. It seldom or never happens that the stratum is of the same temperature throughout. It is commonly much colder aloft; it is also of different constitutions. Below it is warm, loaded with vapour, and very expansible; above it is cold, much drier, and less expansible, both by its dryness and its rarity. The currents of wind are often disposed in strata, which long retain their places; and as they come from different regions, are of different temperatures and different constitutions. We cannot therefore determine the expansion of the whole stratum with precision, and must content ourselves with an approximation: and the best approximation that we can make is, by supposing the whole stratum of a mean temperature between those of its upper and lower extremity, and employ the expansion corresponding to that mean temperature.

This, however, is founded on a gratuitous supposition, that the whole intermediate stratum expands alike, and that the expansion is equable in the different intermediate temperatures; but neither of these are warranted by experiment. Rare air expands less than what is denser; and therefore the general expansion of the whole stratum renders its density more uniform. Dr Horsley has pointed out some curious consequences of this in Phil. Transf. Vol. LXIV. There is a particular elevation at which the general expansion, instead of diminishing the density of the air, increases it by the superior expansion of what is below; and we know that the expansion is not equable in the intermediate temperatures: but we cannot find out a rule which will give us a more accurate correction than by taking the expansion for the mean temperature.

When we have done this, we have carried the method of measuring heights by the barometer as far as it can go; and this source of remaining error makes it needless to attend to some other very minute equations which theory points out. Such is the diminution of the weight of the mercury by the change of distance from the centre of the earth. This accompanies the diminution of the weight of the air, but neither so as to compensate it, nor to go along with it *pari passu*.

After all, there are found cases where there is a regular deviation from those rules, of which we cannot give any very satisfactory account. Thus it is found, that in the province of Quito in Peru, which is at a great elevation above the surface of the ocean, the heights obtained by these rules fall considerably short of the

ter. the real heights; and at Spitsbergen they considerably exceed them. It appears that the air in the circumpolar regions is denser than the air of the temperate climates when of the same heat and under the same pressure; and the contrary seems to be the case with the air in the torrid zone. It would seem that the specific gravity of air to mercury is at Spitsbergen about 1 to 10224, and in Peru about 1 to 13100. This difference is with great probability ascribed to the greater dryness of the circumpolar air.

This source of error will always remain; and it is combined with another, which should be attended to by all who practise this method of measuring heights, namely, a difference in the specific gravity of the quicksilver. It is thought sufficiently pure for a barometer when it is cleared of all calcinable matter, so as not to drag or sully the tube. In this state it may contain a considerable portion of other metals, particularly of silver, bismuth, and tin, which will diminish its specific gravity. It has been obtained by revivification from cinnabar of the specific gravity 14,229, and it is thought very fine if 13,65. Sir George Shuckbourgh found the quicksilver which agreed precisely with the atmospherical observations on which the rules are founded to have the specific gravity 13,61. It is seldom obtained so heavy. It is evident that these variations will change the whole results; and that it is absolutely necessary, in order to obtain precision, that we know the density of the mercury employed. The subtangent of the atmospherical logarithmic, or the height of the homogeneous atmosphere, will increase in the same proportion with the density of the mercury; and the elevation corresponding to $\frac{1}{10}$ of an inch of barometric height will change in the same proportion.

We must be contented with the remaining imperfections: and we can readily see, that, for any purpose that can be answered by such measurements of great heights, the method is sufficiently exact; but it is quite inadequate to the purpose of taking accurate levels, for directing the construction of canals, aqueducts, and other works of this kind, where extreme precision is absolutely necessary.

We shall now deduce from all that has been said on this subject sets of easy rules for the practice of this mode of measurement, illustrating them by an example.

1. *M. de Luc's Method.*

o of ring s by ro- ac- g to ic,

I. Subtract the logarithm of the barometrical height at the upper station from the logarithm of that at the lower, and count the index and four first decimal figures of the remainder as fathoms, the rest as a decimal fraction. Call this the *elevation*.

II. Note the different temperatures of the mercury at the two stations, and the mean temperature. Multiply the logarithmic expansion corresponding to this mean temperature (in Table B, p. 126.) by the difference of the two temperatures, and subtract the product from the elevation if the barometer has been coldest at the upper station, otherwise add it. Call the difference or the sum the *approximated elevation*.

III. Note the difference of the temperatures of the air at the two stations by a detached thermometer, and also the mean temperature and its difference from 32°. Multiply this difference by the expansion of air for the mean temperature, and multiply the approximate elevation by 1 ± this product, according as the air is above or below 32°. The product is the correct elevation in fathoms and decimals.

Example.

Suppose that the mercury in the barometer at the lower station was at 29,4 inches, that its temperature was 50°, and the temperature of the air was 45; and let the height of the mercury at the upper station be 25,19 inches, its temperature 46, and the temperature of the air 39. Thus we have

☿al Hts.	Temp. ☿.	Mean.	Temp. Air.	Mean.
29,4	50	48	45	42
25,19	46		39	

I. Log. of 29,4	-	1.4683473
Log. of 25.19	- -	1.4012282
Elevation in fathoms	- -	671,191
II. Expans. for 48°	,473	
Multiply by -	4	
	-	1,892
Approximated elevation	-	669,299
III. Expans. of air at 42	0,00238	
×42—32,=10°	10	
	0,0238	
Multiply	- -	669,2990
By	- - -	1,0238
Product = the correct elevation		685,228

2. *Sir George Shuckbourgh's Method.*

I. Reduce the barometric heights to what they would be if they were of the temperature 32°. 271 And according to Shuckbourgh.

II. The difference of the logarithms of the reduced barometrical heights will give the approximate elevation.

III. Correct the approximated elevation as before.

Same Example.

I. Mean expans. for 1° from Tab. A, p. 125. is 0,000111.

18°×0,000111×29,4=	- -	0,059
Subtract this from	- -	29,4
Reduced barometric height	-	29,341
Expans. from Tab. A, p. 125. is 0,000111.		
14°×0,000111×25,19	- -	0,039
Subtract from	- -	25,190
Reduced barometric height	-	25,151
II. Log. 29,341	- -	1.4674749
Log. 25,151	- -	1.4005553
Approximated elevation	-	669,196
III. This multiplied by 1,0238 gives		685,125

Remark 1. If 0,000101 be supposed the mean expansion of mercury for 1°, as Sir George Shuckbourgh determines it, the reduction of the barometric heights will be had sufficiently exact by multiplying the obser- 272 Remarks on this method.

Barometer ved heights of the mercury by the difference of its temperatures from 32, and cutting off four more decimal places; thus $29,4\frac{\times 18}{10000}$ gives for the reduced height 29,347, and $25,19\times\frac{14}{10000}$ gives 25,155, and the difference of their logarithms gives 669,4 fathoms for the approximated elevation, which differs from the one given above by no more than 15 inches.

273 *Remark* 2. If 0,0024 be taken for the expansion of air for one degree, the correction for this expansion will be had by multiplying the approximated elevation by 12, and this product by the sum of the differences of the temperatures from 32°, counting that difference as negative when the temperature is below 32, and cutting off four places; thus $669,196\times 12\times\overline{13+07}\times\frac{1}{10000}=$ 16,061, which added to 669,196 gives 685,257, differing from the former only 9 inches.

274 An easy rule without the help of tables.

From the same premises we may derive a rule, which is abundantly exact for all geodætical purposes, and which requires no tables of any kind, and is easily remembered.

1. The height through which we must rise in order to produce any fall of the mercury in the barometer, is inversely proportional to the density of the air, that is, to the height of the mercury in the barometer.

2. When the barometer stands at 30 inches, and the air and quicksilver are of the temperature 32, we must rise through 87 feet, in order to produce a depression of $\frac{1}{10}$ of an inch.

3. But if the air be of a different temperature, this 87 feet must be increased or diminished by 0,21 of a foot for every degree of difference of the temperature from 32°.

4. Every degree of difference of the temperatures of the mercury at the two stations makes a change of 2,833 feet, or 2 feet 10 inches in the elevation.

Hence the following rule.

275 1. Take the difference of the barometric heights in tenths of an inch. Call this *d*.

2. Multiply the difference *a* between 32, and the mean temperature of the air by 21, and take the sum or difference of this product and 87 feet. This is the height through which we must rise to cause the barometer to fall from 30 inches to 29,9. Call this height *h*.

Let *m* be the mean between the two barometric heights. Then $\frac{30\,d\,h}{m}$ is the approximated elevation very nearly.

Multiply the difference δ of the mercurial temperatures by 2,83 feet, and add this product to the approximated elevation if the upper barometer has been the warmest, otherwise subtract it. The result, that is, the sum or difference, will be the corrected elevation.

Same Example.

$$d=294-251,9=42,1$$
$$h=87+10\times 0,21,=89,1$$
$$m=\frac{29,4+25.19}{2}=27,29$$

Approx. elevation $=\frac{30\times 42,1\times 89,1}{27,29}$,	=4123,24 feet.
Corr. for temp. of mercury, $=4\times 2,83$	1132
Corrected elevation in feet -	4111,92
Ditto in fathoms - -	685,32

Differing from the former only 15 inches.

This rule may be expressed by the following simple and easily remembered formula, where *a* is the difference between 32° and the mean temperature of the air, *d* is the difference of barometric heights in tenths of an inch, *m* is the mean barometric height, δ the difference between the mercurial temperatures, and E is the correct elevation. $E=\frac{30(87\pm 0,21a)d}{m}\pm\delta\times 2,83$.

Heights of the remarkable mountains.

We shall now conclude this subject by an account of some of the most remarkable mountains, &c. on the earth, above the surface of the ocean, in feet.

Mount Puy de Domme in Auvergne, the first mountain measured by the barometer		5088
Mount Blanc	Alps	15662
Monte Rosa	Alps	15084
Aiguille d'Argenture	Alps	13402
Monastery of St Bernard	Alps	7944
Mount Cenis		9212
Pic de los Reyes	Pyrennees	7620
Pic du Medi	Pyrennees	9300
Pic d'Ossano	Pyrennees	11700
Canegou	Pyrennees	8544
Lake of Geneva		1232
Mount Ætna		10954
Mount Vesuvius		3938
Mount Hekla in Iceland		4887
Snowdown		3555
Ben Moir		3723
Ben Laurs		3858
Ben Gloe		3472
Shihallion		3461
Ben Lomond		3180
Tinto		2342
Table Hill, Cape of Good Hope		3454
Gondar city in Abyssinia		8440
Source of the Nile		8082
Pic of Teneriffe		14026
Chimboraçon		19595
Cayambourow		19391
Antisana		19290
Pichinha (see Peru, n° 56.)		15670
City of Quito (see ditto)		9977
Caspian Sea below the ocean		306

This last is so singular, that it is necessary to give the authority on which this determination is founded. It is deduced from nine years observations with the barometer at Astrachan by Mr Lecre, compared with a series of observations made with the same barometer at St Petersburgh.

Improved barometer with description by Hook.

This employment of the barometer has caused it to become a very interesting instrument to the philosopher and to the traveller; and many attempts have been made of late to improve it, and render it more portable. The improvements have either been directed to the enlargement

largement of its range, or to the more accurate meaſurement of its preſent ſcale. Of the firſt kind are Hooke's wheel barometer, the diagonal barometer, and the horizontal barometer, deſcribed in a former volume of this work. See BAROMETER. In that place are alſo deſcribed two very ingenious contrivances of Mr Rownings; which are evidently not portable. Of all the barometers with an enlarged ſcale the beſt is that invented by Dr Hooke in 1668, and deſcribed in the Phil. Tranſ. N° 185. The invention was alſo claimed by Huyghens and by De la Hire; but Hooke's was publiſhed long before.

It conſiſts of a compound tube ABCDEFG (fig. 56.), of which the parts AB and DE are equally wide, and EFG as much narrower as we would amplify the ſcale. The parts AB and EG muſt alſo be as perfectly cylindrical as poſſible. The part HBCDI is filled with mercury, having a vacuum above in AB. IF is filled with a light fluid, and FG with another light fluid which will not mix with that in IF. The ciſtern G is of the ſame diameter as AB. It is eaſy to ſee that the range of the ſeparating ſurface at F muſt be as much greater than that of the ſurface I as the area of I is greater than that of F. And this ratio is in our choice. This barometer is free from all the bad qualities of thoſe formerly deſcribed, being moſt delicately moveable; and is by far the fitteſt for a chamber, for amuſement, by obſervations on the changes of the atmoſpheric preſſure. The ſlighteſt breeze cauſes it to riſe and fall, and it is continually in motion.

But this, and all other contrivances of the kind, are inferior to the common barometer for meaſurement of heights, on account of their bulk and cumberſomeneſs: nay, they are inferior for all philoſophical purpoſes in point of accuracy; and this for a reaſon that admits of no reply. Their ſcale muſt be determined in all its parts by the common barometer; and therefore, notwithſtanding their great range, they are ſuſceptible of no greater accuracy than that with which the ſcale of a common barometer can be obſerved and meaſured. This will be evident to any perſon who will take the trouble of conſidering how the points of their ſcale muſt be aſcertained. The moſt accurate method for graduating ſuch a barometer as we have now deſcribed would be to make a mixture of vitriolic acid and water, which ſhould have $\frac{1}{10}$ of the denſity of mercury. Then, let a long tube ſtand vertical in this fluid, and connect its upper end with the open end of the barometer by a pipe which has a branch to which we can apply the mouth. Then if we ſuck through this pipe, the fluid will riſe both in the barometer and in the other tube; and 10 inches riſe in this tube will correſpond to one inch deſcent in the common barometer. In this manner may every point of the ſcale be adjuſted in due proportion to the reſt. But it ſtill remains to determine what particular point of the ſcale correſponds to ſome determined inch of the common barometer. This can only be done by an actual compariſon; and this being done, the whole becomes equally accurate. Except therefore for the mere purpoſe of chamber amuſement, in which caſe the barometer laſt deſcribed has a decided preference, the common barometer is to be preferred; and our attention ſhould be entirely directed to its improvement and portability.

For this purpoſe it ſhould be furniſhed with two microſcopes or magnifying glaſſes, one of them ſtationed at the beginning of the ſcale; which ſhould either be moveable, ſo that it may always be brought to the ſurface of the mercury in the ciſtern, or the ciſtern ſhould be ſo contrived that its ſurface may always be brought to the beginning of the ſcale. The glaſs will enable us to ſee the coincidence with accuracy. The other microſcope muſt be moveable, ſo as to be ſet oppoſite to the ſurface of the mercury in the tube; and the ſcale ſhould be furniſhed with a vernier which divides an inch into 1000 parts, and be made of materials of which we know the expanſion with great preciſion.

For an account of many ingenious contrivances to the make inſtrument accurate, portable, and commodious, conſult Magellan, *Diſſer. de diverſes Inſtr. de Phyſ.*; *Phil. Tranſ.* lxvii. lxviii.; *Journ. de Phyſ.* xix. 108. 346. xvi. 392. xviii. 391. xxi. 436. xxii. 390.; Sulzer, *Act. Helvet.* iii. 259.; De Luc, *Recherches ſur les Modifications de l'Atmoſphere*, i. 401. ii. 459, 490. De Luc's ſeems the moſt ſimple and perfect of them all. Cardinal de Luynes (*Mem. Par.* 1768); Prinſ. De Luc, *Recherches*, § 63.; Van Swinden's *Poſitiones Phyſicæ*; *Com. Acad. Petrop.* i.; *Com. Acad. Petrop. Nov.* ii. 200. viii. 283

THUS we have given an elementary account of the diſtinguiſhing properties of air as a heavy and compreſſible fluid, and of the general phenomena which are immediate conſequences of theſe properties. This we have done in a ſet of propoſitions analogous to thoſe which form the doctrines of hydroſtatics. It remains to conſider it in another point of view, namely, as moveable and inert. The phenomena conſequent on theſe properties are exhibited in the velocities which air acquires by preſſure, in the reſiſtance which bodies meet with to their motion through the air, and in the impreſſion which air in motion gives to bodies expoſed to its action.

We ſhall firſt conſider the motions of which air is ſuſceptible when the equilibrium of preſſure (whether ariſing from its weight or its elaſticity) is removed; and, in the next place, we ſhall conſider its action on ſolid bodies expoſed to its current, and the reſiſtance which it makes to their motion through it.

282 Doctrine of air in acceſſible ſituations as acted on by equal and parallel gravity

In this conſideration we ſhall avoid the extreme of generality, which renders the diſcuſſion too abſtract and difficult, and adapt our inveſtigation to the circumſtances in which compreſſible fluids (of which air is taken for the repreſentative) are moſt commonly found. We ſhall conſider air therefore as it is commonly found in acceſſible ſituations, as acted on by equal and parallel gravity; and we ſhall conſider it in the ſame order in which water is treated in a ſyſtem of hydraulics.

283 Analogous to the doctrine of water in hydraulics.

In that ſcience the leading problem is to determine with what velocity the water will move through a given orifice when impelled by ſome known preſſure; and it has been found, that the beſt form in which this moſt difficult and intricate propoſition can be put, is to determine the velocity of water flowing through this orifice when impelled by its weight alone. Having determined this, we can reduce to this caſe every queſtion which can be propoſed; for, in place of the preſſure of any piſton or other mover, we can always ſubſtitute a perpendicular column of water or air whoſe weight ſhall be equal to the given preſſure.

284 The velocity with which air ruſhes into a void by its own weight.

The firſt problem, therefore, is to determine with what velocity air will ruſh into a void when impelled by

Air in Motion.

by its weight alone. This is evidently analogous to the hydraulic problem of water flowing out of a veſſel.

And here we muſt be contented with referring our readers to the ſolutions which have been given of that problem, and the demonſtration that it flows with the velocity which a heavy body would acquire by falling from a height equal to the depth of the hole under the ſurface of the water in the veſſel. In whatever way we attempt to demonſtrate that propoſition, every ſtep, nay, every word, of the demonſtration applies equally to the air, or to any fluid whatever. Or, if our readers ſhould wiſh to ſee the connection or analogy of the caſes, we only deſire them to recollect an undoubted maxim in the ſcience of motion, that *when the moving force and the matter to be moved vary in the ſame proportion, the velocity will be the ſame.* If therefore there be ſimilar veſſels of air, water, oil, or any other fluid, all of the height of a homogeneous atmoſphere, they will all run through equal and ſimilar holes with the ſame velocity; for in whatever proportion the quantity of matter moving through the hole be varied by a variation of denſity, the preſſure which forces it out, by acting in circumſtances perfectly ſimilar, varies in the ſame proportion by the ſame variation of denſity.

We muſt therefore aſſume it as the leading propoſition, that *air ruſhes from the atmoſphere into a void with the velocity which a heavy body would acquire by falling from the top of a homogeneous atmoſphere.*

It is known that air is about 840 times lighter than water, and that the preſſure of the atmoſphere ſupports water at the height of 33 feet nearly. The height therefore of a homogeneous atmoſphere is nearly 33×840, or 27720 feet. Moreover, to know the velocity acquired by any fall, recollect that a heavy body by falling one foot acquires the velocity of 8 feet per ſecond; and that the velocities acquired by falling thro' different heights are as the ſquare roots of the heights. Therefore, to find the velocity correſponding to any height, expreſſed in feet per ſecond, multiply the ſquare root of the height by 8. We have therefore in the preſent inſtance $V = 8\sqrt{27220}, = 8 \times 166{,}493, = 1332$ feet per ſecond. This therefore is the velocity with which common air will ruſh into a void; and this may be taken as a ſtandard number in pneumatics, as 16 and 32 are ſtandard numbers in the general ſcience of mechanics, expreſſing the action of gravity at the ſurface of the earth.

It is eaſy to ſee that greater preciſion is not neceſſary in this matter. The height of a homogeneous atmoſphere is a variable thing, depending on the temperature of the air. If this reaſon ſeems any objection againſt the uſe of the number 1332, we may retain $8\sqrt{H}$ in place of it, where H expreſſes the height of a homogeneous atmoſphere of the given temperature. A variation of the barometer makes no change in the velocity, nor in the height of the homogeneous atmoſphere, becauſe it is accompanied by a proportional variation in the denſity of the air. When it is increaſed $\frac{1}{10}$, for inſtance, the denſity is alſo increaſed $\frac{1}{10}$; and thus the expelling force and the matter to be moved are changed in the ſame proportion, and the velocity remains the ſame. N. B. We do not here conſider the velocity which the air acquires after its iſſuing into the void by its continual expanſion. This may be aſcertained by the 39th prop. of Newton's *Principia*, b. i. Nay, which appears very paradoxical, if a cylinder of air, communicating in this manner with a void, be compreſſed by a piſton loaded with a weight, which preſſes it down as the air flows out, and thus keeps it of the ſame denſity, the velocity of efflux will ſtill be the ſame however great the preſſure may chance to be: for the firſt and immediate effect of the load on the piſton is to reduce the air in the cylinder to ſuch a denſity that its elaſticity ſhall exactly balance the load; and becauſe the elaſticity of air is proportional to its denſity, the denſity of the air will be increaſed in the ſame proportion with the load, that is, with the expelling power (for we are neglecting at preſent the weight of the included air as too inconſiderable to have any ſenſible effect.) Therefore, ſince the matter to be moved is increaſed in the ſame proportion with the preſſure, the velocity will be the ſame as before.

28 And the velocity with which it ruſhes into a space containing rarer air.

It is equally eaſy to determine the velocity with which the air of the atmoſphere will ruſh into a ſpace containing rarer air. Whatever may be the denſity of this air, its elaſticity, which follows the proportion of its denſity, will balance a proportional part of the preſſure of the atmoſphere; and it is the exceſs of this laſt only which is the moving force. The matter to be moved is the ſame as before. Let D be the natural denſity of the air, and δ the denſity of the air contained in the veſſel into which it is ſuppoſed to run, and let P be the preſſure of the atmoſphere, and therefore equal to the force which impels it into a void; and let π be the force with which this rarer air would run into a void. We have $D : \delta = P : \pi$, and $\pi = \frac{P\delta}{D}$. Now the moving force in the preſent inſtance is $P - \pi$, or $P - \frac{P\delta}{D}$. Laſtly, let V be the velocity of air ruſhing into a void, and v the velocity with which it will ruſh into this rarefied air.

It is a theorem in the motion of fluids, that the preſſures are as the ſquares of the velocities of efflux. Therefore $P : P - \frac{P\delta}{D} = V^2 : v^2$. Hence we derive $v^2 = V^2 \times \overline{1 - \frac{\delta}{D}}$, and $v = V \times \sqrt{1 - \frac{\delta}{D}}$. We do not here conſider the reſiſtance which the air of the atmoſphere will meet with from the inertia of that in the veſſel which it muſt diſplace in its motion.

Here we ſee that there will always be a current into the veſſel while δ is leſs than D.

We alſo learn the gradual diminution of the velocity as the veſſel fills; for δ continually increaſes, and therefore $1 - \frac{\delta}{D}$ continually diminiſhes.

It remains to determine the time t expreſſed in ſeconds, in which the air of the atmoſphere will flow into this veſſel from its ſtate of vacuity till the air in the veſſel has acquired any propoſed denſity δ.

For this purpoſe let H, expreſſed in feet, be the height through which a heavy body muſt fall in order to acquire the velocity V, expreſſed alſo in feet per ſecond. This we ſhall expreſs more briefly in future, by calling it the height producing the velocity V. Let C repreſent the capacity of the veſſel, expreſſed in cubic feet,

feet, and O the area or section of the orifice, expressed in superficial or square feet; and let the natural density of the air be D.

Since the quantity of aerial matter contained in a vessel depends on the capacity of the vessel and the density of the air jointly, we may express the air which would fill this vessel by the symbol CD when the air is in its ordinary state, and by $C\delta$ when it has the density δ. In order to obtain the rate at which it fills, we must take the fluxion of this quantity $C\delta$. This is $C\dot{\delta}$; for C is a constant quantity, and δ is a variable or flowing quantity.

But we also obtain the rate of influx by our knowledge of the velocity, and the area of the orifice, and the density. The velocity is V, or $8\sqrt{H}$, at the first instant; and when the air in the vessel has acquired the density δ, that is, at the end of the time t, the velocity is $8\sqrt{H}\sqrt{1-\frac{\delta}{D}}$, or $8\sqrt{H}\sqrt{\frac{D-\delta}{D}}$, or $8\sqrt{H}\frac{\sqrt{D-\delta}}{\sqrt{D}}$.

The rate of influx therefore (which may be conceived as measured by the little mass of air which will enter during the time $\dot{t}$ with this velocity) will be $\frac{8\sqrt{H}OD\sqrt{D-\delta}\,\dot{t}}{\sqrt{D}}$, or $8\sqrt{H}O\sqrt{D}\sqrt{D-\delta}\,\dot{t}$, multiplying the velocity by the orifice and by the density.

Here then we have two values of the rate of influx. By stating them as equal we have a fluxionary equation, from which we may obtain the fluents, that is, the time t in seconds necessary for bringing the air in the vessel to the density δ, or the density δ which will be produced at the end of any time t. We have the equation $8\sqrt{H}O\sqrt{D}\sqrt{D-\delta}\,\dot{t}=C\dot{\delta}$. Hence we derive $\dot{t}=\frac{C}{8\sqrt{H}O\sqrt{D}}\times\frac{\dot{\delta}}{\sqrt{D-\delta}}$. Of this the fluent is $t=\frac{C}{4\sqrt{H}O\sqrt{D}}\times\sqrt{D-\delta}+A$, in which A is a conditional constant quantity. The condition which determines it is, that t must be nothing when δ is nothing, that is, when $\sqrt{D-\delta}=\sqrt{D}$; for this is evidently the case at the beginning of the motion. Hence it follows, that the constant quantity is $\sqrt{D}$, and the complete fluent, suited to the case, is

$$\frac{C}{4\sqrt{H}O\sqrt{D}}\times\overline{\sqrt{D}-\sqrt{D-\delta}}.$$

The motion ceases when the air in the vessel has acquired the density of the external air; that is, when $\delta=D$, or when $t=\frac{C}{4\sqrt{H}O\sqrt{D}}\times\sqrt{D}$, $=\frac{C}{4\sqrt{H}O}$. Therefore the time of completely filling the vessel is $\frac{C}{4\sqrt{H}O}$.

286 Illustrated by examples in numbers. Let us illustrate this by an example in numbers.

Supposing then that air is 840 times lighter than water, and the height of the homogeneous atmosphere 27720 feet, we have $4\sqrt{H}=666$. Let us further suppose the vessel to contain 8 cubic feet, which is nearly a wine hogshead, and that the hole by which the air of the ordinary density, which we shall make $=1$, enters is an inch square, or $\frac{1}{144}$ of a square foot. Then the time in seconds of completely filling it will be $\frac{8''}{\frac{1}{144}666}$, or $\frac{1152''}{666}$, or $1,7297''$. If the hole is only $\frac{1}{100}$ of a square inch, that is, if its side is $\frac{1}{10}$ of an inch, the time of completely filling the hogshead will be $173''$ very nearly, or something less than three minutes.

If we make the experiment with a hole cut in a thin plate, we shall find the time greater nearly in the proportion of 63 to 100, for reasons obvious to all who have studied hydraulics. In like manner we can tell the time necessary for bringing the air in the vessel to $\frac{3}{4}$ of its ordinary density. The only variable part of our fluent is the coefficient $-\sqrt{D-\delta}$, or $\sqrt{1-\delta}$. Let δ be $=\frac{3}{4}$, then $\sqrt{1-\delta}=\sqrt{\frac{1}{4}}=\frac{1}{2}$, and $1-\sqrt{1-\delta}=\frac{1}{2}$; and the time is $86\frac{1}{2}''$ very nearly when the hole is $\frac{1}{10}$ of an inch wide.

Plate CCCCV.

287 The velocity of air with the additional impulse of a weight moving down the vessel.

Let us now suppose that the air in the vessel ABCD (fig. 64.) is compressed by a weight acting on the cover AD, which is moveable down the vessel, and is thus expelled into the external air.

The immediate effect of this external pressure is to compress the air and give it another density. The density D of the external air corresponds to its pressure P. Let the additional pressure on the cover of the vessel be p, and the density of the air in the vessel be d. We shall have $P:P+p=D:d$; and therefore $p=P\times\frac{d-D}{D}$. Then, because the pressure which expels the air is the difference between the force which compresses the air in the vessel and the force which compresses the external air, the expelling force is p. And because the quantities of motion are as the forces which similarly produce them, we shall have $P:P\times\frac{d-D}{D}=MV:mv$; where M and m express the quantities of matter expelled, V expresses the velocity with which air rushes into a void, and v expresses the velocity sought. But because the quantities of aerial matter which issue from the same orifice in a moment are as the densities and velocities jointly, we shall have $MV:mv=DVV:dvv$, $=DV^2:dv^2$. Therefore $P:p\frac{d-D}{D}=DV^2:dv$. Hence we deduce $v=V\sqrt{\frac{d-D}{d}}$.

We may have another expression of the velocity without considering the density. We had $P:P+p=D:d$: therefore $d=\frac{D\times\overline{P+p}}{P}$, and $d-D=\frac{D\times\overline{P+p}}{P}-D$, $=\frac{D\times\overline{P+p}-DP}{P}$, and $\frac{d-D}{d}=\frac{D\times\overline{P+p}-DP}{D\times\overline{P+p}}$, $=\frac{P+p-P}{P+p}$, $=\frac{p}{P+p}$: therefore $v=V\times\sqrt{\frac{p}{P+p}}$, which is a very simple and convenient expression.

288 The effect of the air's elasticity considered.

Hitherto we have considered the motion of air as produced by its weight only. Let us now consider the effect of its elasticity.

Let ABCD (fig. 64.) be a vessel containing air of any density D. This air is in a state of compression; and if the compressing force be removed, it will expand, and its elasticity will diminish along with its density. Its

Air in Motion.

Its elasticity in any state is measured by the force which keeps it in that state. The force which keeps common air in its ordinary density is the weight of the atmosphere, and is the same with the weight of a column of water 33 feet high. If therefore we suppose that this air, instead of being confined by the top of the vessel, is pressed down by a moveable piston carrying a column of water 33 feet high, its elasticity will balance this pressure as it balances the pressure of the atmosphere; and as it is a fluid, and propagates through every part the pressure exerted on any one part, it will press on any little portion of the vessel by its elasticity in the same manner as when loaded with this column.

The consequence of this reasoning is, that if this small portion of the vessel be removed, and thus a passage be made into a void, the air will begin to flow out with the same velocity with which it would flow when impelled by its weight alone, or with the velocity acquired by falling from the top of a homogeneous atmosphere, or 1332 feet in a second nearly.

But as soon as some air has come out, the density of the remaining air is diminished, and its elasticity is diminished; therefore the expelling force is diminished. But the matter to be moved is diminished in the very same proportion, because the density and elasticity are found to vary according to the same law; therefore the velocity will continue the same from the beginning to the end of the efflux.

This may be seen in another way. Let P be the pressure of the atmosphere, which being the counterbalance and measure of the initial elasticity, is equal to the expelling force at the first instant. Let D be the initial density, and V the initial velocity. Let d be its density at the end of the time t of efflux, and v the contemporaneous velocity. It is plain that at the end of this time we shall have the expelling force $\pi = \frac{\mathrm{P}d}{\mathrm{D}}$; for $\mathrm{D} : d = \mathrm{P} : \pi \left(= \frac{\mathrm{P}d}{\mathrm{D}}\right)$.

These forces are proportional to the quantities of motion which they produce; and the quantities of motion are proportional to the quantities of matter M and m and the velocities V and v jointly: therefore we have $\mathrm{P} : \frac{\mathrm{P}d}{\mathrm{D}} = \mathrm{MV} : mv$. But the quantities of matter which escape through a given orifice are as the densities and velocities jointly; that is, $\mathrm{M} : m = \mathrm{DV} : dv$: therefore $\mathrm{P} : \frac{\mathrm{P}d}{\mathrm{D}} = \mathrm{DV}^2 : dv^2$, and $\mathrm{P} \times dv^2 = \frac{\mathrm{P}d\mathrm{DV}^2}{\mathrm{D}} = \mathrm{P}d\mathrm{V}^2$, and $\mathrm{V}^2 = v^2$, and $\mathrm{V} = v$, and the velocity of efflux is constant. Hence follows, what appears very unlikely at first sight, that however much the air in the vessel is condensed, it will always issue into a void with the same velocity.

289 Quantity of air issuing into a void in a given time, and the density at the end of that time.

In order to find the quantity of aerial matter which will issue during any time t, and consequently the density of the remaining air at the end of this time, we must get the rate of efflux. In the element of time $\dot{t}$ there issues (by what has been said above) the bulk $8\sqrt{\mathrm{HO}}\dot{t}$ (for the velocity V is constant); and therefore the quantity $8\sqrt{\mathrm{HO}}d\dot{t}$. On the other hand, the quantity of air at the beginning was CD, C being the capacity of the vessel; and when the air has acquired the density d, the quantity is Cd, and the quantity run out is $\mathrm{CD} - \mathrm{C}d$; therefore the quantity which has run out in the time $\dot{t}$ must be the fluxion of $\mathrm{CD} - \mathrm{C}d$, or $-\mathrm{C}\dot{d}$. Therefore we have the equation $8\sqrt{\mathrm{HO}}d\dot{t} = -\mathrm{C}\dot{d}$, and $\dot{t} = \frac{-\mathrm{C}\dot{d}}{8\sqrt{\mathrm{HO}}d}$; $= \frac{\mathrm{C}}{8\sqrt{\mathrm{HO}}} \times -\frac{\dot{d}}{d}$.

The fluent of this is $t = \frac{\mathrm{C}}{8\sqrt{\mathrm{HO}}} \log. d$. This fluent must be so taken that t may be $= 0$ when $d = \mathrm{D}$. Therefore the correct fluent will be $t = \frac{\mathrm{C}}{8\sqrt{\mathrm{HO}}} \log. \frac{\mathrm{D}}{d}$, for $\log. \frac{\mathrm{D}}{\mathrm{D}} = \log. 1, = 0$. We deduce from this, that it requires an infinite time for the whole air of a vessel to flow out of it into a void. N. B. By log. d, &c. is meant the hyperbolic logarithm of d, &c.

290 When a vessel emits it into rarer air.

Let us next suppose that the vessel, instead of letting out its air into a void, emits it into air of a less density, which remains constant during the efflux, as we may suppose to be the case when a vessel containing condensed air emits it into the surrounding atmosphere. Let the initial density of the air in the vessel be δ, and that of the atmosphere D. Then it is plain that the expelling force is $\mathrm{P} - \frac{\mathrm{PD}}{\delta}$, and that after the time t it is $\frac{\mathrm{P}d}{\delta} - \frac{\mathrm{PD}}{\delta}$. We have therefore $\mathrm{P} - \frac{\mathrm{PD}}{\delta} : \frac{\mathrm{P}d}{\delta} - \frac{\mathrm{PD}}{\delta} = \mathrm{MV} : mv, = \delta \mathrm{V}^2 : dv^2$. Whence we derive $v = \mathrm{V}\sqrt{\frac{\delta\,\overline{d - \mathrm{D}}}{d\,\overline{\delta - \mathrm{D}}}}$

From this equation we learn that the motion will be at an end when $d = \mathrm{D}$: and if $\delta = \mathrm{D}$ there can be no efflux.

291 Relation between the time and density when issuing into a void.

To find the relation between the time and the density, let H as before be the height producing the velocity V. The height producing the velocity of efflux v must be $\mathrm{H} \times \frac{\delta\,\overline{d - \mathrm{D}}}{d\,\overline{\delta - \mathrm{D}}}$, and the little parcel of air which will flow out in the time $\dot{t}$ will be $= 8\sqrt{\mathrm{HO}}\,d\,\dot{t}\sqrt{\frac{\delta\,\overline{d - \mathrm{D}}}{d\,\overline{\delta - \mathrm{D}}}}$. On the other hand, it is $= -\mathrm{C}\dot{d}$.

Hence we deduce the fluxionary equation $\dot{t} = \frac{\mathrm{C}\sqrt{\delta - \mathrm{D}}}{8\sqrt{\mathrm{HO}}\sqrt{\delta}} \times \frac{-\dot{d}}{\sqrt{d^2 - \mathrm{D}d}}$. The fluent of this, corrected so as to make $t = 0$ when $d = \delta$, is $t = \frac{\mathrm{C}\sqrt{\delta - \mathrm{D}}}{8\sqrt{\mathrm{HO}}\sqrt{\delta}} \times \log. \left(\frac{\delta - \frac{1}{2}\mathrm{D} + \sqrt{\delta^2 - \mathrm{D}\delta}}{d - \frac{1}{2}\mathrm{D} + \sqrt{d^2 - \mathrm{D}d}}\right)$. And the time of completing the efflux, when $d = \mathrm{D}$, is $t = \frac{\mathrm{C}\sqrt{\delta - \mathrm{D}}}{8\sqrt{\mathrm{HO}}\sqrt{\delta}} \times \log. \left(\frac{\delta - \frac{1}{2}\mathrm{D} + \sqrt{\delta^2 - \mathrm{D}\delta}}{\frac{1}{2}\mathrm{D}}\right)$.

Plate CCCC[C...]. 292 When issuing from denser into rarer air.

Lastly, let ABCD, CFGH (fig. 65.) be two vessels containing airs of different densities, and communicating by the orifice C, there will be a current from the vessel containing the denser air into that containing the rarer: suppose from ABCD into CFGH.

Let P be the elastic force of the air in ABCD, Q its

its denſity, and V its velocity, and D the denſity of the air in CFGH. And, after the time t, let the denſity of the air in ABCD be q, its velocity v, and the denſity of the air in CFGH be δ. The expelling force from ABCD will be $P - \frac{PD}{Q}$ at the firſt inſtant, and at the end of the time t it will be $\frac{Pq}{Q} - \frac{P\delta}{Q}$. Therefore we ſhall have $P - \frac{PD}{Q} : \frac{Pq}{Q} - \frac{P\delta}{Q} = QV^2 : qv^2$, which gives $v = V \times \sqrt{\frac{Q(q - \delta)}{q(Q-D)}}$, and the motion will ceaſe when $\delta = q$.

Let A be the capacity of the firſt veſſel, and B that of the ſecond. We have the ſecond equation $AQ + BD = Aq + B\delta$, and therefore $\delta = \frac{A(Q-q)+BD}{B}$. Subſtituting this value of δ in the former value of v, we have $v = V \times \sqrt{\frac{Q[B(q-D) - A(Q-q)]}{q\,B(Q-D)}}$, which gives the relation between the velocity v and the denſity q.

In order to aſcertain the time when the air in ABCD has acquired the denſity q, it will be convenient to abridge the work by ſome ſubſtitutions. Therefore make $Q(B+A) = M$, $BQD + BQ^2 = N$, $BQ - BD = R$ and $\frac{N}{M} = m$. Then, proceeding as before, we obtain the fluxionary equation $8\sqrt{HO}\,q\frac{\sqrt{Mq-N}}{\sqrt{R}\sqrt{q}}\dot{t} = \dot{\overline{AQ-Aq}} = -A\dot{q}$ whence $\dot{t} = \frac{A\sqrt{R}}{8\sqrt{HO}\sqrt{M}} \times \frac{\dot{q}}{\sqrt{q^2 - mq}}$ of which the fluent, completed ſo that $t=0$ when $q = Q$, is $t = \frac{A\sqrt{R}}{8\sqrt{HO}\sqrt{M}} \times \text{Log}\left(\frac{Q - \frac{1}{2}m + \sqrt{(Q^2 mQ)}}{q - \frac{1}{2}m + \sqrt{(q^2 mq)}}\right)$.

293 Air expelled by force, as bellows.

Some of theſe queſtions are of difficult ſolution, and they are not of frequent uſe in the more important and uſual applications of the doctrines of pneumatics, at leaſt in their preſent form. The caſes of greateſt uſe are when the air is expelled from a veſſel by an external force, as when bellows are worked, whether of the ordinary form or conſiſting of a cylinder fitted with a moveable piſton. This laſt caſe merits a particular conſideration; and, fortunately, the inveſtigation is extremely eaſy.

Plate CCCV.

Let AD fig. 64. be conſidered as a piſton moving downward with the uniform velocity f, and let the area of the piſton be n times the area of the hole of efflux, then the velocity of efflux ariſing from the motion of the piſton will be nf. Add this to the velocity V produced by the elaſticity of the air in the firſt queſtion, and the whole velocity will be $V + nf$. It will be the ſame in the others. The problem is alſo freed from the conſideration of the time of efflux. For this depends now on the velocity of the piſton. It is ſtill, however, a very intricate problem to aſcertain the relation between the time and the denſity, even though the piſton is moving uniformly; for at the beginning of the motion the air is of common denſity. As the piſton deſcends, it both expels and compreſſes the air, and the denſity of the air in the veſſel varies in a very intricate manner, as alſo its reſiſtance or reaction on the piſton. For this reaſon, a piſton which moves uniformly by means of an external force will never make an uniform blaſt by ſucceſſive ſtrokes; it will always be weaker at the beginning of the ſtroke. The beſt way for ſecuring an uniform blaſt is to employ the external force only for lifting up the piſton, and then to let the piſton deſcend by its own weight. In this way it will quickly ſink down, compreſſing the air, till its denſity and correſponding elaſticity exactly balance the weight of the piſton. After this the piſton will deſcend equably, and the blaſt will be uniform. We ſhall have occaſion to conſider this more particulary under the head of *Pneumatical Machines*. Theſe obſervations and theorems will ſerve to determine the initial velocity of the air in all important caſes of its expulſion. The philoſopher will learn the rate of its efflux out of one veſſel into another; the chemiſt will be able to calculate the quantities of the different gaſes which are employed in the curious experiments of the ingenious but unfortunate Lavoiſier on Combuſtion, and will find them extremely different from what he ſuppoſed; the engineer will learn how to proportion the motive force of his machine to the quantity of aerial matter which his bellows muſt ſupply. But it is not enough, for this purpoſe, that the air *begin* to iſſue in the proper quantity; we muſt ſee whether it be not affected by the circumſtances of its ſubſequent paſſage.

294 Paſſage of air through pipes, &c. ſimilar to the motion of water in conduits.

All the modifications of motion which are obſerved in water conduits take place alſo in the paſſage of air through pipes and holes of all kinds. There is the ſame diminution of quantity paſſing through a hole in a thin plate that is obſerved in water. We know that (abating the ſmall effect of friction) water iſſues with the velocity acquired by falling from the ſurface; and yet if we calculate by this velocity and by the area of the orifice, we ſhall find the quantity of water deficient nearly in the proportion of 63 to 100. This is owing to the water preſſing towards the orifice from all ſides, which occaſions a contraction of the jet. The ſame thing happens in the efflux of air. Alſo the motion of water is greatly impeded by all contractions of its paſſage. Theſe oblige it to accelerate its velocity, and therefore require an increaſe of preſſure to force it through them, and this in proportion to the ſquares of the velocities. Thus, if a machine working a pump cauſes it to give a certain number of ſtrokes in a minute, it will deliver a determined quantity of water in that time. Should it happen that the paſſage of the water is contracted to one half in any part of the machine (a thing which frequently happens at the valves), the water muſt move through this contraction with twice the velocity that it has in the reſt of the paſſage. This will require four times the force to be exerted on the piſton. Nay (which will appear very odd, and is never ſuſpected by engineers), if no part of the paſſage is narrower than the barrel of the pump, but on the contrary a part much wider, and if the conduit be again contracted to the width of the barrel, an additional force muſt be applied to the piſton to drive the water through this paſſage, which would not have been neceſſary if the paſſage had not been widened in any part. It will require a force equal to the weight of a column of water of the height neceſſary for communicating a velocity the ſquare of which is equal to the difference of the ſquares of the velocities of the water in the wide and the narrow part of the conduit.

Air in Motion.

The same thing takes place in the motion of air, and therefore all contractions and dilatations must be carefully avoided, when we want to preserve the velocity unimpaired.

295 Air suffers the same retardation along pipes as water, and the necessity of attending to this.

Air also suffers the same retardation in its motion along pipes. By not knowing, or not attending to that, engineers of the first reputation have been prodigiously disappointed in their expectations of the quantity of air which will be delivered by long pipes. Its extreme mobility and lightness hindered them from suspecting that it would suffer any sensible retardation. Dr Papin, a most ingenious man, proposed this as the most effectual method of transferring the action of a moving power to a great distance. Suppose, for instance, that it was required to raise water out of a mine by a water-machine, and that there was no fall of water nearer than a mile's distance. He employed this water to drive a piston, which should compress the air in a cylinder communicating, by a long pipe, with another cylinder at the mouth of the mine. This second cylinder had a piston in it, whose rod was to give motion to the pumps at the mine. He expected, that as soon as the piston at the water-machine had compressed the air sufficiently, it would cause the air in the cylinder at the mine to force up its piston, and thus work the pumps. Doctor Hooke made many objections to the method, when laid before the Royal Society, and it was much debated there. But dynamics was at this time an infant science, and very little understood. Newton had not then taken any part in the business of the society, otherwise the true objections would not have escaped his sagacious mind. Notwithstanding Papin's great reputation as an engineer and mechanic, he could not bring his scheme into use in England; but afterwards, in France and in Germany, where he settled, he got some persons of great fortunes to employ him in this project; and he erected great machines in Auvergne and Westphalia for draining mines. But, so far from being effective machines, they would not even begin to move. He attributed the failure to the quantity of air in the pipe of communication, which must be condensed before it can condense the air in the remote cylinder. This indeed is true, and he should have thought of this earlier. He therefore diminished the size of this pipe, and made his water-machine exhaust instead of condensing, and had no doubt but that the immense velocity with which air rushes into a void would make a rapid and effectual communication of power. But he was equally disappointed here, and the machine at the mine stood still as before.

Near a century after this, a very intelligent engineer attempted a much more feasible thing of this kind at an iron-foundery in Wales. He erected a machine at a powerful fall of water, which worked a set of cylinder bellows, the blow pipe of which was conducted to the distance of a mile and a half, where it was applied to a blast furnace. But notwithstanding every care to make the conducting pipe very air-tight, of great size, and as smooth as possible, it would hardly blow out a candle. The failure was ascribed to the impossibility of making the pipe air-tight. But, what was surprising, above ten minutes elapsed after the action of the pistons in the bellows before the least wind could be perceived at the end of the pipe; whereas the engineer expected an interval of 6 seconds only.

295 No distinct theory of this subject.

No very distinct theory can be delivered on this subject; but we may derive considerable assistance in understanding the causes of the obstruction to the motion of water in long pipes, by considering what happens to air. The elasticity of the air, and its great compressibility, have given us the distinctest notions of fluidity in general, showing us, in a way that can hardly be controverted, that the particles of a fluid are kept at a distance from each other, and from other bodies, by the corpuscular forces. We shall therefore take this opportunity to give a view of the subject, which did not occur to us when treating of the motion of water in pipes, reserving a further discussion to the articles River, *Water-Works*.

296 How fluids are obstructed moving along canals.

The writers on hydrodynamics have always considered the obstruction to the motion of fluids along canals of any kind, as owing to something like the friction by which the motion of solid bodies on each other is obstructed; but we cannot form to ourselves any distinct notion of resemblance, or even analogy between them. The fact is, however, that a fluid running along a canal has its motion obstructed; and that this obstruction is greatest in the immediate vicinity of the solid canal, and gradually diminishes to the middle of the stream. It appears, therefore, that the parts of fluids can no more move among each other than among solid bodies, without suffering a diminution of their motion. The parts in physical contact with the sides and bottom are retarded by these immoveable bodies. The particles of the next stratum of fluid cannot preserve their initial velocities without overpassing the particles of the first stratum; and it appears from the fact that they are by this means retarded. They retard in the same manner the particles of the third stratum, and so on to the middle stratum or thread of fluid. It appears from the fact, therefore, that this sort of friction is not a consequence of rigidity alone, but that it is equally competent to fluids. Nay, since it is a matter of fact in air, and is even more remarkable there than in any other fluid, as we shall see by the experiments which have been made on the subject; and as our experiments on the compression of air show us the particles of air ten times nearer to each other in some cases than in others (viz. when we see air a thousand times denser in these cases), and therefore force us to acknowledge that they are not in contact; it is plain that this obstruction has no analogy to friction, which supposes roughness or inequality of surface. No such inequality can be supposed in the surface of an aerial particle; nor would it be of any service in explaining the obstruction, since the particles do not rub on each other, but pass each other at some small and imperceptible distance.

We must therefore have recourse to some other mode of explication. We shall apply this to air only in this place; and, since it is proved by the uncontrovertible experiments of Canton, Zimmerman, and others, that water, mercury, oil, &c. are also compressible and perfectly elastic, the argument from this principle, which is conclusive in air, must equally explain the similar phenomenon in hydraulics.

The most highly polished body which we know must be conceived as having an uneven surface when we compare it with the small spaces in which the corpuscular forces are exerted; and a quantity of air moving in

in a polished pipe may be compared to a quantity of small shot sliding down a channel with undulated sides and bottom. The row of particles immediately contiguous to the sides will therefore have an undulated motion: but this undulation of the contiguous particles of air will not be so great as that of the surface along which they glide; for not only every motion requires force to produce it, but also every change of motion. The particles of air resist this change from a rectilineal to an undulating motion; and, being elastic, that is, repelling each other and other bodies, they keep a little nearer to the surface as they are passing over an eminence, and their path is less incurvated than the surface. The difference between the motion of the particles of air and the particles of a fluid quite unelastic is, in this respect, somewhat like the difference between the motion of a spring-carriage and that of a common carriage. When the common carriage passes along a road not perfectly smooth, the line described by the centre of gravity of the carriage keeps perfectly parallel to that described by the axis of the wheels, rising and falling along with it. Now let a spring body be put on the same wheels and pass along the same road. When the axis rises over an eminence perhaps half an inch, sinks down again into the next hollow, and then rises a second time, and so on, the centre of gravity of the body describes a much straighter line; for upon the rising of the wheels, the body resists the motion, and compresses the springs, and thus remains lower than it would have been had the springs not been interposed. In like manner, it does not sink so low as the axle does when the wheels go into a hollow. And thus the motion of spring-carriages becomes less violently undulated than the road along which they pass. This illustration will, we hope, enable the reader to conceive how the deviation of the particles next to the sides and bottom of the canal from a rectilineal motion is less than that of the canal itself.

It is evident that the same reasoning will prove that the undulation of the next row of particles will be less than that of the first, that the undulation of the third row will be less than that of the second, and so on, as is represented in fig. A. Plate CCCCV. And thus it appears, that while the mass of air has a progressive motion along the pipe or canal, each particle is describing a waving line, of which a line parallel to the direction of the canal is the axis, cutting all these undulations. This axis of each undulated path will be straight or curved as the canal is, and the excursions of the path on each side of its axis will be less and less as the axis of the path is nearer to the axis of the canal.

Let us now see what *sensible* effect this will have; for all the motion which we here speak of is imperceptible. It is demonstrated in mechanics, that if a body moving with any velocity be deflected from its rectilineal path by a curved and perfectly smooth channel, to which the rectilineal path is a tangent, it will proceed along this channel with undiminished velocity. Now the path, in the present case, may be considered as perfectly smooth, since the particles do not touch it. It is one of the undulations which we are considering, and we may at present conceive this as without any subordinate inequalities. There should not, therefore, be any diminution of the velocity. Let us grant this of the absolute velocity of the particle; but what we observe is the velocity of the mass, and we judge of it perhaps by the motion of a feather carried along by it. Let us suppose a single atom to be a sensible object, and let us attend to two such particles, one at the side, and the other in the middle: although we cannot perceive the undulations of these particles during their progressive motions, we see the progressive motions themselves. Let us suppose then that the middle particle has moved without any undulation whatever, and that it has advanced ten feet. The lateral particle will also have moved ten feet; but this has not been in a straight line. It will not be so far advanced, therefore, in the direction of the canal; it will be left behind, and will appear to us to have been retarded in its motion: and in like manner each thread of particles will be more and more retarded (apparently only) as it recedes farther from the axis of the canal, or what is usually called the thread of the stream.

300 But on the whole the undulatory motion is a real obstruction.

And thus the observed fact is shown to be a necessary consequence of what we know to be the nature of a compressible or elastic fluid; and that without supposing any diminution in the real velocity of each particle, there will be a diminution of the velocity of the sensible threads of the general stream, and a diminution of the whole quantity of air which passes along it during a given time.

Let us now suppose a parcel of air impelled along a pipe, which is *perfectly* smooth, out of a larger vessel, and issuing from this pipe with a certain velocity. It requires a certain force to change its velocity in the vessel to the greater velocity which it has in the pipe. This is abundantly demonstrated. How long soever we suppose this pipe, there will be no change in the velocity, or in the force to keep it up. But let us suppose that about the middle of this pipe there is a part of it which has suddenly got an undulated surface, however imperceptible. Let us further suppose that the final velocity of the middle thread is the same as before. In this case it is evident that the sum total of the motions of all the particles is greater than before, because the absolute motions of the lateral particles is greater than that of the central particle, which we suppose the same as before. This absolute increase of motion cannot be without an increase of propelling force: the force acting now, therefore, must be greater than the force acting formerly. Therefore, if only the former force had continued to act, the same motion of the central particle could not have been preserved, or the progressive motion of the whole stream must be diminished.

And thus we see that this internal insensible undulatory motion becomes a real obstruction to the sensible motion which we observe, and occasions an expence of power.

301 An additional force necessary for preserving a given progressive motion.

Let us see what will be the consequence of extending this obstructing surface further along the canal. It must evidently be accompanied by an augmentation of the motion produced, if the central velocity be still kept up; for the particles which are now in contact with the sides do not continue to occupy that situation: the middle particles moving faster *forward* get over them, and in their turn come next the side; and as they are really moving equally fast, but not in the direction into which they are now to be forced, force is

Air in Motion.

neceffary for changing the direction alfo; and this is in addition to the force neceffary for producing the undulations fo minutely treated of. The confequence of this muft be, that an additional force will be neceffary for preferving a given progreffive motion in a longer *obftructing* pipe, and that the motion produced in a pipe of greater length by a given force will be lefs than in a fhorter one, and the efflux will be diminifhed.

302 Efpecially through any contraction.

There is another confideration which muft have an influence here. Nothing is more irrefragably demonftrated than the neceffity of an additional force for producing an efflux through any contraction, even though it fhould be fucceeded by a dilatation of the paffage. Now both the inequalities of the fides and the undulations of the motions of each particle are equivalent to a fucceffion of contractions and dilatations; although each of thefe is next to infinitely fmall; their number is alfo next to infinitely great, and therefore the total effect may be fenfible.

303 There are befides other obftructions, as angular afperities, &c.

We have hitherto fuppofed that the abfolute velocity of the particles was not diminifhed: this we did, having affumed that the interval of each undulation of the fides was without inequalities. But this was gratuitous: it was alfo gratuitous that the fides were only undulated. We have no reafon for excluding angular afperities. Thefe will produce, and moft certainly often produce, real diminutions in the velocity of the contiguous particles; and this muft extend to the very axis of the canal, and produce a diminution of the fum total of motion: and in order to preferve the fame fenfible progreffive motion, a greater force muft be employed. This is all that can be meant by faying that there is a refiftance to the motion of air through long pipes.

304 And a want of perfect fluidity.

There remains another caufe of diminution, viz. the want of perfect fluidity, whether arifing from the diffemination of folid particles in a real fluid, or from the vifcidity of the fluid. We fhall not infift on this at prefent, becaufe it cannot be fhown to obtain in air, at leaft in any cafe which deferves confideration. It feems of no importance to determine the motion of air hurrying along with it foot or duft. The effect of fogs on a particular modification of the motion of air will be confidered under the article Sound. What has been faid on this fubject is fufficient for our purpofe, as explaining the prodigious and unexpected obftruction to the paffage of air through long and narrow pipes. We are able to collect an important maxim from it, viz. that all pipes of communication fhould be made as wide as circumftances will permit: for it is plain that the obftruction depends on the internal furface, and the force to overcome it muft be in proportion to the mafs of matter which is in motion. The firft increafes as the diameter of the pipe, and the laft as the fquare. The obftruction muft therefore bear a greater proportion to the whole motion in a fmall pipe than in a large one.

305 The law of retardation extending from the axis to the fides of the canal unknown.

It were very defirable to know the law by which the retardation extends from the axis to the fides of the canal, and the proportion which fubfifts between the lengths of canal and the forces neceffary for overcoming the obftructions when the velocity is given; as alfo whether the proportion of the obftruction to the whole motion varies with the velocity: but all this is unknown. It does not, however, feem a defperate cafe in air: we know pretty diftinctly the law of action among its particles, viz. that their mutual repulfions are inverfely as their diftances. This promifes to enable us to trace the progrefs of undulation from the fides of the canal to the axis.

306 It will not increafe fo faft as the fquare of the velocities.

We can fee that the retardations will not increafe fo faft as the fquare of the velocity. Were the fluid incompreffible, fo that the undulatory path of a particle were invariable, the deflecting forces by which each individual particle is made to defcribe its undulating path would be precifely fuch as arife from the path itfelf and the motion in it; for each particle would be in the fituation of a body moving along a fixed path. But in a very compreffible fluid, fuch as air, each particle may be confidered as a folitary body, actuated by a projectile and a tranfverfe force, arifing from the action of the adjoining particles. Its motion muft depend on the adjuftment of thefe forces, in the fame manner as the elliptical motion of a planet depends on the adjuftment of the force of projection, with a gravitation inverfely proportional to the fquare of the diftance from the focus. The tranfverfe force in the prefent cafe has its origin in the preffure on the air which is propelling it along the pipe: this, by fqueezing the particles together, brings their mutual repulfion into action. Now it is the property of a perfect fluid, that a preffure exerted on any part of it is propagated equally through the whole fluid; therefore the tranfverfe forces which are excited by this preffure are proportional to the preffure itfelf: and we know that the preffures exerted on the furface of a fluid, fo as to expel it through any orifice, or along any canal, are proportional to the fquares of the velocities which they produce. Therefore, in every point of the undulatory motion of any particle, the tranfverfe force by which it is deflected into a curve is proportional to the fquare of its velocity. When this is the cafe, a body would continue to defcribe the fame curve as before; but, by the very compreffion, the curvatures are increafed, fuppofing them to remain fimilar. This would require an increafe of the tranfverfe forces; but this is not to be found: therefore the particle will not defcribe a fimilar curve, but one which is lefs incurvated in all its parts; confequently the progreffive velocity of the whole, which is the only thing perceivable by us, will not be fo much diminifhed; that is, the obftructions will not increafe fo faft as they would otherwife do, or as the fquares of the velocities.

This reafoning is equally applicable to all fluids, and is abundantly confirmed by experiments in hydraulics, as we fhall fee when confidering the motion of rivers. We have taken this opportunity of delivering our notions on this fubject; becaufe, as we have often faid, it is in the avowed difcrete conftitution of air that we fee moft diftinctly the operation of thofe natural powers which conftitute fluidity in general.

307 M. Boffut's experiments on pipes and canals.

We would beg leave to mention a form of experiment for difcovering the law of retardation with confiderable accuracy. Experiments have been made on pipes and canals. Mr Boffut, in his *Hydrodynamique*, has given a very beautiful fet made on pipes of an inch and two inches diameter, and 200 feet long: but although thefe experiments are very inftructive, they do not give us any rule by which we can extend the refult to pipes of greater length and different diameters.

Let a fmooth cylinder be fet upright in a very large veffel or pond, and be moveable round its axis: let it be turned

turned round by means of a wheel and pulley with an uniform motion and determined velocity. It will exert the same force on the contiguous water which would be exerted on it by water turning round it with the same velocity: and as this water would have its motion gradually retarded by the fixed cylinder, so the moving cylinder will gradually communicate motion to the surrounding water. We should observe the water gradually dragged round by it; and the vortex would extend farther and farther from it as the motion is continued, and the velocities of the parts of the vortex will be less and less as we recede from the axis. Now, we apprehend, that when a point of the surface of the cylinder has moved over 200 feet, the *motion* of the water at different distances from it will be similar and proportional to, if not precisely the same with, the *retardations* of water flowing 200 feet at the same distance from the side of a canal: at any rate, the two are susceptible of an accurate comparison, and the law of retardation may be accurately deduced from observations made on the motions of this vortex.

308 Air in motion is a very familiar object of observation; and it is interesting. In all languages it has got a name; we call it wind: and it is only upon reflection that we consider air as wind in a quiescent state. Many persons hardly know what is meant when air is mentioned; but they cannot refuse that the blast from a bellows is the expulsion of what they contained; and thus they learn that wind is air in motion.

309 It is of consequence to know the velocity of wind; but no good and unexceptionable method has been contrived for this purpose. The best seems to be by measuring the space passed over by the shadow of a cloud; but this is extremely fallacious. In the first place, it is certain, that although we suppose that the cloud has the velocity of the air in which it is carried along, this is not an exact measure of the current on the surface of the earth; we may be almost certain that it is greater: for air, like all other fluids, is retarded by the sides and bottom of the channel in which it moves. But, in the next place, it is very gratuitous to suppose, that the velocity of the cloud is the velocity of the stratum of air between the cloud and the earth; we are almost certain that it is not. It is abundantly proved by Dr Hutton of Edinburgh, that clouds are always formed when two parcels of air of different temperatures mix together, each containing a proper quantity of vapour in the state of chemical solution. We know that different strata of air will frequently flow in different directions for a long time. In 1781 while a great fleet rendezvouzed in Leith Roads during the Dutch war, there was a brisk easterly wind for about five weeks; and, during the last fortnight of this period, there was a brisk westerly current at the height of about $\frac{1}{4}$ of a mile. This was distinctly indicated by frequent fleecy clouds at a great distance above a lower stratum of these clouds, which were driving all this time from the eastward. A gentleman who was at the siege of Quebec in 1759, informed us, that one day while there blew a gale from the west, so hard that the ships at anchor in the river were obliged to strike their topmasts, and it was with the utmost difficulty that some well manned boats could row against it, carrying some artillery stores to a post above the town, several shells were thrown from the town to destroy the boats: one of the shells burst in the air near the top of its flight, which was about half a mile high. The smoke of this bomb remained in the same spot for above a quarter of an hour, like a great round ball, and gradually dissipated by diffusion, without removing many yards from its place. When, therefore, two strata of air come from different quarters, and one of them flows over the other, it will be only in the contiguous surfaces that a precipitation of vapour will be made. This will form a thin fleecy cloud; and it will have a velocity and direction which neither belongs to the upper nor to the lower stratum of air which produced it. Should one of these strata come from the east and the other from the west with equal velocities, the cloud formed between them will have no motion at all; should one come from the east, and the other from the north, the cloud will move from the north-east with a greater velocity than either of the strata. So uncertain then is the information given by the clouds either of the velocity or the direction of the wind. A thick smoke from a furnace will give us a much less equivocal measure: and this, combined with the effects of the wind in impelling bodies, or deflecting a loaded plane from the perpendicular, or other effects of this kind, may give us measures of the different currents of wind with a precision sufficient for all practical uses.

Velocity of Wind.

310 The result of Smeaton's observation on this head.

The celebrated engineer Mr John Smeaton has given, in the 51st volume of the Philosophical Transactions, the velocities of wind corresponding to the usual denominations in our language. These are founded on a great number of observations made by himself in the course of his practice in erecting wind-mills. They are contained in the following table.

Miles per hour.	Feet per second.	Names.
1	1,47	
2	2,93	Light airs.
3	4,40	
4	5,87	Breeze.
5	7,33	
10	14,67	Brisk gale.
15	22,	
20	29,34	Fresh gale.
25	36,67	
30	44,01	Strong gale.
35	51,34	
40	58,68	Hard gale.
45	66,01	
50	73,35	Storm.
60	88,02	
80	117,36	Hurricane, turning up trees, overturning buildings, &c.
100	146,70	

See also some valuable experiments by him on this subject, Philosophical Transactions 1760 and 1761.

311 Account of Dr Lynd's anemometer.

One of the most ingenious and convenient methods for measuring the velocity of the wind is to employ its pressure in supporting a column of water, in the same way as Mr Pitot measures the velocity of a current of water. We believe that it was first proposed by Dr James Lynd of Windsor, a gentleman eminent for his great knowledge in all the branches of natural science, and for his ingenuity in every matter of experiment or practical application.

His anemometer (as these instruments are called) consists of a glass tube of the form ABCD (fig. 66.), open at

Plate CCCCV.

Velocity of Wind

at both ends, and having the branch AB at right angles to the branch CD. This tube contains a few inches of water or any fluid (the lighter the better); it is held with the part CD upright, and AB horizontal and in the direction of the wind; that is, with the mouth A fronting the wind. The wind acts in the way of preſſure on the air in AB, compreſſes it, and cauſes it to preſs on the ſurface of the liquor, forcing it down to F, while it riſes to E in the other leg. The velocity of the wind is concluded from the difference E*f* between the heights of the liquor in the legs. As the wind does not generally blow with uniform velocity, the liquor is apt to dance in the tube, and render the obſervation difficult and uncertain: to remedy this, it is proper to contract very much the communication at C between the two legs. If the tube has half an inch of diameter (and it ſhould not have leſs), a hole of $\frac{1}{10}$ of an inch is large enough; indeed the hole can hardly be too ſmall, nor the tubes too large.

312 It is ingenious and uſeful.

This inſtrument is extremely ingenious, and will undoubtedly give the proportions of the velocities of different currents with the greateſt preciſion; for in whatever way the preſſure of wind is produced by its motion, we are certain that the different preſſures are as the ſquares of the velocities: if, therefore, we can obtain one certain meaſure of the velocity of the wind, and obſerve the degree to which the preſſure produced by it raiſes the liquor, we can at all other times obſerve the preſſures and compute the velocities from them, making proper allowances for the temperature and the height of the mercury in the barometer; becauſe the velocity will be in the ſubduplicate ratio of the denſity of the air inverſely when the preſſure is the ſame.

It is uſually concluded, that the velocity of the wind is that which would be acquired by falling from a height which is to E*f* as the weight of water is to that of an equal bulk of air. Thus, ſuppoſing air to be 840 times lighter than water, and that E*f* is $\frac{9}{10}$ of an inch, the velocity will be about 63 feet *per* ſecond, which is that of a very hard gale, approaching to a ſtorm. Hence we ſee by the bye, that the ſcale of this inſtrument is extremely ſhort, and that it would be a great improvement of it to make the leg CD not perpendicular, but very much ſloping; or perhaps the following form of the inſtrument will give it all the perfection of which it is capable. Let the horizontal branch AB (fig. 67.) be contracted at B, and continued horizontally for ſeveral inches BG of a much ſmaller bore, and then turned down for two or three inches GC, and then upwards with a wide bore. To uſe the inſtrument, hold it with the part DC perpendicular; and (having ſheltered the mouth A from the wind) pour in water at D till it advances along GB to the point B, which is made the beginning of the ſcale; the water in the upright branch ſtanding at *f* in the ſame horizontal line with BG. Now, turn the mouth A to the wind; the air in AB will be compreſſed and will force the water along BG to F, and cauſe it to riſe from *f* to E; and the range *f*E will be to the range BF on the ſcale as the ſection of the tube BG to that of CD. Thus, if the width of DC be $\frac{1}{2}$ an inch, and that of BG $\frac{1}{10}$, we ſhall have 25 inches in the ſcale for one inch of real preſſure E*f*.

Plate CCCCV.

But it has not been demonſtrated in a very ſatisfactory manner, that the velocity of the wind is that acquired by falling through the height of a column of air whoſe weight is equal to that of the column of water E*f*. Experiments made with Pitot's tube in currents of water ſhow that ſeveral corrections are neceſſary for concluding the velocity of the current from the elevations in the tube: theſe corrections may however be made, and ſafely applied to the preſent caſe; and then the inſtrument will enable us to conclude the velocity of the wind immediately, without any fundamental compariſon of the elevation, with a velocity actually determined upon other principles. The chief uſe which we have for this information is in our employment of wind as an impelling power, by which we can actuate machinery or navigate ſhips. Theſe are very important applications of pneumatical doctrines, and merit a particular conſideration; and this naturally brings us to the laſt part of our ſubject, viz. the conſideration of the impulſe of air on bodies expoſed to its action, and the reſiſtance which it oppoſes to the paſſage of bodies through it.

313 This ſubject is important, but it is ſo difficult.

This is a ſubject of the greateſt importance; being the foundation of that art which has done the greateſt honour to the ingenuity of man, and the greateſt ſervice to human ſociety, by connecting together the moſt diſtant inhabitants of this globe, and making a communication of benefits which would otherwiſe have been impoſſible; we mean the art of Navigation or Seamanſhip. Of all the machines which human art has conſtructed, a ſhip is not only the greateſt and moſt magnificent, but alſo the moſt ingenious and intricate; and the clever ſeaman poſſeſſes a knowledge founded on the moſt difficult and abſtruſe doctrines of mechanics. The ſeaman probably cannot give any account of his own ſcience; and he poſſeſſes it rather by a kind of intuition than by any proceſs of reaſoning: but the ſucceſs and efficacy of all the mechaniſm of this complicated engine, and the propriety of all the manœuvres which the ſeaman practiſes, depend on the invariable laws of mechanics; and a thorough knowledge of theſe would enable an intelligent perſon not only to underſtand the machine and the manner of working it, but to improve both.

Unfortunately this is a ſubject of very great difficulty; and although it has employed the genius of Newton, and he has conſidered it with great care, and his followers have added more to his labours on this ſubject than on any other, it ſtill remains in a very imperfect ſtate.

A minute diſcuſſion of this ſubject cannot therefore be expected in a work like this: we muſt content ourſelves with ſuch a general ſtatement of the moſt approved doctrine on the ſubject as ſhall enable our readers to conceive it diſtinctly, and judge with intelligence and confidence of the practical deductions which may be made from it.

314 Impulſe and reſiſtance of air.

It is evidently a branch of the general theory of the impulſe and reſiſtance of fluids, which ſhould have been treated of under the article Hydraulics, but was then deferred till the mechanical properties of compreſſible fluids ſhould alſo be conſidered. It was thought very reaſonable to ſuppoſe that the circumſtances of elaſticity would introduce the ſame changes in the impulſe and reſiſtance of fluids that it does in ſolid bodies. It would greatly divert the attention from the diſtinctive properties of air, if we ſhould in this place enter on this ſubject, which is both extenſive and difficult. We reckon it better therefore to take the whole together: this we ſhall do under the article *Resistance of Fluids*, and confine ourſelves at preſent to what relates to the

impulſe

impulſe and reſiſtance of air alone; anticipating a few of the general propoſitions of that theory, but without demonſtration, in order to underſtand the applications which may be made of it.

Suppoſe then a plane ſurface, of which aC (fig. 68.) is the ſection, expoſed to the action of a ſtream of wind blowing in the direction QC, perpendicular to aC. The motion of the wind will be obſtructed, and the ſurface aC preſſed forward. And as all impulſe or preſſure is exerted in a direction perpendicular to the ſurface, and is reſiſted in the oppoſite direction, the ſurface will be impelled in the direction CD, the continuation of QC. And as the mutual actions of bodies depend on their relative motions, the force acting on the ſurface aC will be the ſame, if we ſhall ſuppoſe the air at reſt, and the ſurface moving equally ſwift in the oppoſite direction. The reſiſtance of the air to the motion of the body will be equal to the impulſe of the air in the former caſe. Thus reſiſtance and impulſe are equal and contrary.

If the air be moving twice as faſt, its particles will give a double impulſe; but in this caſe a double number of particles will exert their impulſe in the ſame time: the impulſe will therefore be fourfold; and in general it will be as the ſquare of the velocity: or if the air and body be both in motion, the impulſe and reſiſtance will be proportional to the ſquare of the relative velocity.

This is the firſt propoſition on the ſubject, and it appears very conſonant to reaſon. There will therefore be ſome analogy between the force of the air's impulſe or the reſiſtance of a body, and the weight of a column of air incumbent on the ſurface: for it is a principle in the action of fluids, that the heights of the columns of fluid are as the ſquares of the velocities which their preſſures produce. Accordingly the ſecond propoſition is, that the abſolute impulſe of a ſtream of air, blowing perpendicularly on any ſurface, is equal to the weight of a column of air which has that ſurface for its baſe, and for its height the ſpace through which a body muſt fall in order to acquire the velocity of the air.

Thirdly, Suppoſe the ſurface AC equal to aC no longer to be perpendicular to the ſtream of air, but inclined to it in the angle ACD, which we ſhall call the *angle of incidence*; then, by the reſolution of forces, it follows, that the action of each particle is diminiſhed in the proportion of radius to the ſine of the angle of incidence, or of AC to AL, AL being perpendicular to CD.

Again: Draw AK parallel to CD. It is plain that no air lying farther from CD than KA is will ſtrike the plane. The quantity of impulſe therefore is diminiſhed ſtill farther in the proportion of aC to KC, or of AC to AL. Therefore, on the whole, the abſolute impulſe is diminiſhed in the proportion of AC^2 to AL^2: hence the propoſition, that the impulſe and reſiſtance of a given ſurface are in the proportion of the ſquare of the ſine of the angle of incidence.

Fourthly, This impulſe is in the direction PL, perpendicular to the impelled ſurface, and the ſurface tends to move in this direction: but ſuppoſe it moveable only in ſome other direction PO, or that it is in the direction PO that we wiſh to employ this impulſe, its action is therefore oblique; and if we wiſh to know the intenſity of the impulſe in this direction, it muſt be diminiſhed ſtill farther in the proportion of radius to the coſine of the angle LPO or ſine of CPO. Hence the general propoſition: The *effective impulſe is as the ſurface, as the ſquare of the velocity of the wind, as the ſquare of the ſine of the angle of incidence, and as the ſine of the obliquity jointly*, which we may expreſs by the ſymbol $R=S\cdot V^2\cdot ſin^2 . I\cdot ſin . O$; and as the impulſe depends on the denſity of the impelling fluid, we may take in every circumſtance by the equation $R=S\cdot D\cdot V^2\cdot ſin .^2 I\cdot ſin . O$. If the impulſe be eſtimated in the direction of the ſtream, the angle of obliquity ACD is the ſame with the angle of incidence, and the impulſe in this direction is as the ſurface, as the ſquare of the velocity, and as the cube of the angle of incidence jointly.

Velocity of Wind.

It evidently follows from theſe premiſes, that if ACA′ be a wedge, of which the baſe AA′ is perpendicular to the wind, and the angle ACA′ biſected by its direction, the direct or perpendicular impulſe on the baſe is to the oblique impulſe on the ſides as radius to the ſquare of the ſine of half the angle ACA′.

The ſame muſt be affirmed of a pyramid or cone ACA′, of which the axis is in the direction of the wind.

If ACA′ (fig. 69.) repreſent the ſection of a ſolid, produced by the revolution of a curve line APC round the axis CD, which lies in the direction of the wind, the impulſe on this body may be compared with the direct impulſe on its baſe, or the reſiſtance to the motion of this body through the air may be compared with the direct reſiſtance of its baſe, by reſolving its ſurface into elementary planes Pp, which are coincident with a tangent plane PR, and comparing the impulſe on Pp with the direct impulſe on the correſponding part Kk of the baſe.

In this way it follows that the impulſe on a ſphere is one half of the impulſe on its great circle, or on the baſe of a cylinder of equal diameter.

316
Important inference from this doctrine.

We ſhall conclude this ſketch of the doctrine with a very important propoſition to determine the moſt advantageous poſition of a plane ſurface, when required to move in one direction while it is impelled by the wind blowing in a different direction. Thus,

Let AB (fig. 70.) be the ſail of a ſhip, CA the direction in which the wind blows, and AD the line of the ſhip's courſe. It is required to place the yard AC in ſuch a poſition that the impulſe of the wind upon the ſail may have the greateſt effect poſſible in impelling the ſhip along AD.

Let AB, Ab, be two poſitions of the ſail very near the beſt poſition, but on oppoſite ſides of it. Draw BE, be, perpendicular to CA, and BF, bf, perpendicular to AD, calling AB radius; it is evident that BE, BF, are the ſines of impulſe and obliquity, and that the effective impulſe is $BE^2\times BF$, or $be^2\times bf$. This muſt be a maximum.

Let the points B, b, continually approach and ultimately coincide; the chord bB will ultimately coincide with a ſtraight line CBD touching the circle in B; the triangles CBE, cbe are ſimilar, as alſo the triangles DBF, Dbf: therefore $BE^2 : be^2 = BC^2 : bc^2$, and $BF : bf = BD : bD$; and $BE^2\times BF : be^2\times bf = CB^2\times BD : cb^2\times bD$. Therefore when AB is in the beſt poſition, ſo that $BE^2\times BF$ is greater than $be^2\times bf$, we ſhall have $CB\times BD$ greater than $Cb^2\times bD$, or $cB^2\times BD$ is alſo a maximum. This we know to be the caſe when $CB=2BD$: therefore the ſail muſt be ſo placed that the

Velocity of Wind.

the tangent of the angle of incidence ſhall be double of the tangent of the angle of the ſail and keel.

In a common windmill the angle CAD is neceſſarily a right angle; for the ſail moves in a circle to which the wind is perpendicular: therefore the beſt angle of the ſail and axle will be 54°.44 nearly.

Such is the theory of the reſiſtance and impulſe of the air. It is extremely ſimple and of eaſy application. In all phyſical theories there are aſſumptions which depend on other principles, and thoſe on the judgment of the naturaliſt; ſo that it is always proper to confront the theory with experiment. There are even circumſtances in the preſent caſe which have not been attended to in the theory. When a ſtream of air is obſtructed by a ſolid body, or when a ſolid body moves along in air, the air is condenſed before it and rarefied behind. There is therefore a preſſure on the anterior parts ariſing from this want of equilibrium in the elaſticity of the air. This muſt be ſuperadded to the force ariſing from the impetus or inertia of the air. We cannot tell with preciſion what may be the amount of this condenſation; it depends on the velocity with which any condenſation diffuſes itſelf.

Alſo, if the motion be ſo rapid that the preſſure of the atmoſphere cannot make the air immediately occupy the place quitted by the body, it will ſuſtain this preſſure on its forepart to be added to the other forces.

317
Account of the principal experiments on this ſubject.

Experiments on this ſubject are by no means numerous; at leaſt ſuch experiments as can be depended on for the foundation of any practical application. The firſt that have this character are thoſe publiſhed by Mr Robins in 1742 in his treatiſe on Gunnery. They were repeated with ſome additions by the Chevalier Borda, and ſome account of them publiſhed in the Memoirs of the Academy of Sciences in 1763. In the Philoſophical Tranſactions of the Royal Society of London, Vol. LXXIII. there are ſome experiments of the ſame kind on a larger ſcale by Mr Edgeworth. Theſe were all made in the way deſcribed in our account of Mr Robins's improvements in gunnery. Bodies were made to move with determined velocities, and the reſiſtances were meaſured by weights.

In all theſe experiments the reſiſtances were found very exactly in the proportion of the ſquares of the velocities; but they were found conſiderably greater than the weight of the column of air, whoſe height would produce the velocity in a falling body. Mr Robins's experiments on a ſquare of 16 inches, deſcribing 25,2 feet per ſecond, indicate the reſiſtance to be to this weight nearly as 4 to 3. Borda's experiments on the ſame ſurface ſtate the diſproportion ſtill greater.

The reſiſtances are found not to be in the proportion of the ſurfaces, but increaſe conſiderably faſter. Surfaces of 9, 16, 36, and 81 inches, moving with one velocity, had reſiſtances in the proportion of 9, $17\frac{1}{2}$, $42\frac{1}{4}$, and $104\frac{1}{2}$.

Now as this deviation from the proportion of the ſurfaces increaſes with great regularity, it is moſt probable that it continues to increaſe in ſurfaces of ſtill greater extent; and theſe are the moſt generally to be met with in practice in the action of wind on ſhips and mills.

Borda's experiments on 81 inches ſhow that the impulſe of wind moving one foot per ſecond is about $\frac{1}{500}$ of a pound on a ſquare foot. Therefore to find the impulſe on a foot correſponding to any velocity, divide the ſquare of the velocity by 500, and we obtain the impulſe in pounds. Mr Rouſe of Leiceſterſhire made many experiments, which are mentioned with great approbation by Mr Smeaton. His great ſagacity and experience in the erection of windmills oblige us to pay a conſiderable deference to his judgment. Theſe experiments confirm our opinion, that the impulſes increaſe faſter than the ſurfaces. The following table was calculated from Mr Rouſe's obſervations, and may be conſidered as pretty near the truth.

Velocity in Feet.	Impulſe on a Foot in Pounds.
0	0,000
10	0,229
20	0,915
30	2,059
40	3,660
50	5,718
60	8,234
70	11,207
80	14,638
90	18,526
100	22,872
110	27,675
120	32,926
130	38,654
140	44,830
150	51,462

If we multiply the ſquare of the velocity in feet by 16, the product will be the impulſe or reſiſtance on a ſquare foot in grains, according to Mr Rouſe's numbers.

The greateſt deviation from the theory occurs in the oblique impulſes. Mr Robins compared the reſiſtance of a wedge, whoſe angle was 90°, with the reſiſtance of its baſe; and inſtead of finding it leſs in the proportion of $\sqrt{2}$ to 1, as determined by the theory, he found it greater in the proportion of 55 to 68 nearly; and when he formed the body into a pyramid, of which the ſides had the ſame ſurface and the ſame inclination as the ſides of the wedge, the reſiſtance of the baſe and face were now as 55 to 39 nearly: ſo that here the ſame ſurface with the ſame inclination had its reſiſtance reduced from 68 to 39 by being put into this form. Similar deviations occur in the experiments of the Chevalier Borda; and it may be collected from both, that the reſiſtances diminiſh more nearly in the proportion of the ſines of incidence than in the proportion of the ſquares of thoſe ſines.

The irregularity in the reſiſtance of curved ſurfaces is as great as in plane ſurfaces. In general, the theory gives the oblique impulſes on plane ſurfaces much too ſmall, and the impulſes on curved ſurfaces too great. The reſiſtance of a ſphere does not exceed the fourth part of the reſiſtance of its great circle, inſtead of being its half; but the anomaly is ſuch as to leave hardly any room for calculation. It would be very deſirable to have the experiments on this ſubject repeated in a greater variety of caſes, and on larger ſurfaces, ſo that the errors of the experiments may be of leſs conſequence. Till this matter be reduced to ſome rule, the art of working ſhips muſt remain very imperfect, as muſt alſo the conſtruction of windmills.

The caſe in which we are moſt intereſted in the know-

knowledge of the refiftance of the air is the motion of bullets and fhells. Writers on artillery have long been fenfible of the great effect of the air's refiftance. It feems to have been this confideration that chiefly engaged Sir Ifaac Newton to confider the motions of bodies in a refifting medium. A propofition or two would have fufficed for fhowing the incompatibility of the planetary motions with the fuppofition that the celeftial fpaces were filled with a fluid matter; but he has with great folicitude confidered the motion of a body projected on the furface of the earth, and its deviation from the parabolic track affigned by Galileo. He has beftowed more pains on this problem than any other in his whole work; and his inveftigation has pointed out almoft all the improvements which have been made in the application of mathematical knowledge to the ftudy of nature. Nowhere does his fagacity and fertility of refource appear in fo ftrong a light as in the fecond book of the *Principia*, which is almoft wholly occupied by this problem. The celebrated mathematician John Bernouilli engaged in it as the fineft opportunity of difplaying his fuperiority. A miftake committed by Newton in his attempt to a folution was matter of triumph to him; and the whole of his performance, though a piece of elegant and elaborate geometry, is greatly hurt by his continually bringing this miftake (which is a mere trifle) into view. The difficulty of the fubject is fo great, that fubfequent mathematicians feem to have kept aloof from it; and it has been entirely overlooked by the many voluminous writers who have treated profeffedly on military projectiles. They have fpoken indeed of the refiftance of the air as affecting the flight of fhot, but have faved themfelves from the tafk of inveftigating this effect (a tafk to which they were unequal), by fuppofing that it was not fo great as to render their theories and practical deductions very erroneous. Mr Robins was the firft who ferioufly examined the fubject. He fhowed, that even the Newtonian theory (which had been corrected, but not in the fmalleft degree improved or extended in its principles) was fufficient to fhow that the path of a cannon ball could not refemble a parabola. Even this theory fhowed that the refiftance was more than eight times the weight of the ball, and fhould produce a greater deviation from the parabola than the parabola deviated from a ftraight line.

This fimple but fingular obfervation was a ftrong proof how faulty the profeffed writers on artillery had been, in rather amufing themfelves with elegant but ufelefs applications of eafy geometry, than in endeavouring to give their readers any ufeful information. He added, that the difference between the ranges by the Newtonian theory and by experiment were fo great, that the refiftance of the air muft be vaftly fuperior to what that theory fuppofed. It was this which fuggefted to him the neceffity of experiments to afcertain this point. We have feen the refult of thefe experiments in moderate velocities; and that they were fufficient for calling the whole theory in queftion, or at leaft for rendering it ufelefs. It became neceffary therefore to fettle every point by means of a direct experiment. Here was a great difficulty. How fhall we meafure either thefe great velocities which are obferved in the motions of cannon fhot, or the refiftances which thefe enormous velocities occafion? Mr Robins had the ingenuity to do both. The method which he took for meafuring the velocity of a mufket-ball was quite original; and it was fufceptible of great accuracy. We have already given an account of it under the article GUNNERY. Having gained this point, the other was not difficult. In the moderate velocities he had determined the refiftances by the forces which balanced them, the weights which kept the refifted body in a ftate of uniform motion. In the great velocities, he propofed to determine the refiftances by their immediate effects, by the retardations which they occafioned. This was to be done by firft afcertaining the velocity of the ball, and then meafuring its velocity after it had paffed thro' a certain quantity of air. The difference of thefe velocities is the retardation, and the proper meafure of the refiftance; for, by the initial and final velocities of the ball, we learn the time which was employed in paffing through this air with the medium velocity. In this time the air's refiftance diminifhed the velocity by a certain quantity. Compare this with the velocity which a body projected directly upwards would lofe in the fame time by the refiftance of gravity. The two forces muft be in the proportion of their effects. Thus we learn the proportion of the refiftance of the air to the weight of the ball. It is indeed true, that the time of paffing through this fpace is not accurately had by taking the arithmetical medium of the initial and final velocities, nor does the refiftance deduced from this calculation accurately correfpond to this mean velocity; but both may be accurately found by the experiment by a very troublefome computation, as is fhown in the 5th and 6th propofitions of the fecond book of Newton's *Principia*. The difference between the quantities thus found and thofe deduced from the fimple procefs is quite trifling, and far within the limits of accuracy attainable in experiments of this kind; it may therefore be fafely neglected.

320 Mr Robins made many experiments on this fubject.

Mr Robins made many experiments on this fubject; but unfortunately he has publifhed only a very few, fuch as were fufficient for afcertaining the point he had in view. He intended a regular work on the fubject, in which the gradual variations of refiftance correfponding to different velocities fhould all be determined by experiment: but he was then newly engaged in an important and laborious employment, as chief engineer to the Eaft India Company, in whofe fervice he went out to India, where he died in lefs than two years. It is to be regretted that no perfon has profecuted thefe experiments. It would be neither laborious nor difficult, and would add more to the improvement of artillery than any thing that has been done fince Mr Robins's death, if we except the profecution of his experiments on the initial velocities of cannon-fhot by Dr Charles Hutton royal profeffor at the Woolwich Academy. It is to be hoped that this gentleman, after having with fuch effect and fuccefs extended Mr Robins's experiments on the initial velocities of mufket-fhot to cannon, will take up this other fubject, and thus give the art of artillery all the fcientific foundation which it can receive in the prefent ftate of our mathematical knowledge. Till then we muft content ourfelves with the practical rules which Robins has deduced from his own experiments. As he has not given us the mode of deduction, we muft compare the refults with experiment. He has indeed given a very extenfive comparifon with the numerous experiments made both in Britain and

Resistance of Air in Gunnery.

and on the continent; and the agreement is very great. His learned commentator Euler has been at no pains to investigate these rules, and has employed himself chiefly in detecting errors, most of which are supposed, because he takes for a finished work what Mr Robins only gives to the public as a hasty but useful sketch of a new and very difficult branch of science.

321 General result of them, &c.

The general result of Robins's experiments on the retardation of musket-shot is, that although in moderate velocities the resistance is so nearly in the duplicate proportion of the velocities that we cannot observe any deviation, yet in velocities exceeding 200 feet per second the retardations increase faster, and the deviation from this rate increases rapidly with the velocity. He ascribes this to the causes already mentioned, viz. the condensation of the air before the ball and to the rarefaction behind, in consequence of the air not immediately occupying the space left by the bullet. This increase is so great, that if the resistance to a ball moving with the velocity of 1700 feet in a second be computed on the supposition that the resistance observed in moderate velocities is increased in the duplicate ratio of the velocity, it will be found hardly one-third part of its real quantity. He found, for instance, that a ball moving thro' 1670 feet in a second lost about 125 feet per second of its velocity in passing through 50 feet of air. This it must have done in the $\frac{1}{32}$ of a second, in which time it would have lost one foot if projected directly upwards; from which it appears that the resistance was about 125 times its weight, and more than three times greater than if it had increased from the resistance in small velocities in the duplicate ratio of the velocities. He relates other experiments which show similar results.

But he also mentions a singular circumstance, that till the velocities exceed 1100 feet per second, the resistances increase pretty regularly, in a ratio exceeding the duplicate ratio of the velocities; but that in greater velocities the resistances become suddenly triple of what they would have been, even according to this law of increase. He thinks this explicable by the vacuum which is then left behind the ball, it being well known that air rushes into a vacuum with the velocity of 1132 feet per second nearly. Mr Euler controverts this conclusion, as inconsistent with that gradation which is observed in all the operations of nature; and says, that although the vacuum is not produced in smaller velocities than this, the air behind the ball must be so rare (the space being but imperfectly filled), that the pressure on the anterior part of the ball must gradually approximate to that pressure which an absolute vacuum would produce; but this is like his other criticisms. Robins does nowhere assert that this sudden change of resistance happens in the transition of the velocity from 1132 feet to that of 1131 feet 11 inches or the like, but only that it is very sudden and very great. It may be strictly demonstrated, that such a change must happen in a narrow enough limit of velocities to justify the appellation of sudden: a similar fact may be observed in the motion of a solid through water. If it be gradually accelerated, the water will be found nearly to fill up its place, till the velocity arrives at a certain magnitude, corresponding to the immersion of the body in the water; and then the smallest augmentation of its motion immediately produces a void behind it, into which the water rushes in a violent manner and is dashed into froth. A gentleman, who has had many opportunities for such observations, assures us, that when standing near the line of direction of a cannon discharging a ball with a large allotment of powder, so that the initial velocity certainly exceeded 1100 feet per second, he always observed a very sudden diminution of the noise which the bullet made during its passage. Although the ball was coming towards him, and therefore its noise, if equable, would be continually increasing, he observed that it was loudest at first. That this continued for a second or two, and suddenly diminished, changing to a sound which was not only weaker, but differed in kind, and gradually increased as the bullet approached him. He said, that the first noise was like the hissing of red-hot iron in water, and that the subsequent noise rather resembled a hazy whistling. Such a change of sound is a necessary consequence of the different agitation of the air in the two cases. We know also, that air rushing into a void, as when we break an exhausted bottle, makes a report like a musket.

322 Partly controverted by Euler, but without sufficient grounds.

Mr Robins's assertion therefore has every argument for its truth that the nature of the thing will admit. But we are not left to this vague reasoning: his experiments show us this diminution of resistance. It clearly appears from them, that in a velocity of 1700 feet the resistance is more than three times the resistance determined by the theory which he supposes the common one. When the velocity was 1065 feet, the actual resistance was $\frac{11}{7}$ of the theoretical; and when the velocity was 400 feet, the actual resistance was about $\frac{4}{3}$ of the theoretical. That he assumed a theory of resistance which gave them all too small, is of no consequence in the present argument.

3[23] Rule of Robi[ns for] comp[uting] resist[ances] and v[ery] rapid [mo]tions.

Mr Robins, in summing up the results of his observations on this subject, gives a rule very easily remembered for computing the resistances to those very rapid motions. It has been already mentioned in the article Gunnery, but we repeat it here, in order to accommodate it to the quantities which have been determined in some degree by experiment.

A C B D

Let AB represent the velocity of 1700 feet per second, and AC any other velocity. Make BD to AD as the resistance given by the ordinary theory to the resistance actually observed in the velocity 1700: then will CD be to AD as the resistance assigned by the ordinary theory to the velocity AC is to that which really corresponds to it.

To accommodate this to experiment, recollect* that a sphere of the size of a 12 pound iron shot, moving 25 feet in a second, had a resistance of $\frac{1}{22}$ of a pound. Augment this in the ratio of 25^2 to 1700^2, and we obtain 210 nearly for the theoretical resistance to this velocity; but by comparing its diameter of $4\frac{1}{2}$ inches with $\frac{3}{4}$, the diameter of the leaden ball, which had a resistance of at least 11 pounds with this velocity, we conclude that the 12 pound shot would have had a resistance of 396 pounds: therefore BD : AD = 210 : 396, and AB : AD = 186 : 396; and AB being 1700, AD will be 3613.

Let $AD = a$, $AC = x$, and let R be the resistance to a 12 pound iron shot moving one foot per second, and r the resistance (in pounds) wanted for the velocity x; we

* See [Gun]nery, &c.

Resi[stance] of A[ir in] Gun[nery].

ation ir.

we have $r=R\frac{a x^2}{a-x}$. Mr Robins's experiments give $R=\frac{1}{13750}$ very nearly. This gives $Ra=0{,}263235$, which is nearly one-fourth. Thus our formula becomes $r=\frac{0{,}263235\, x^2}{3613-x}$, or very nearly $\frac{x^2}{4(3613-x)}$, falling short of the truth about $\frac{1}{20}$th part. The simplicity of the formula recommends it to our use, and when we increase its result $\frac{1}{20}$, it is incomparably nearer to the true result of the theory as corrected by Mr Robins than we can hope that the theory is to the actual resistance. We can easily see that Mr Robins's correction is only a sagacious approximation. If we suppose the velocity 3613 feet, a very possible thing, the resistance by this formula is infinite, which cannot be. We may even suppose that the resistance given by the formula is near the truth only in such velocities as do not greatly exceed 1700 feet per second. No military projectile exceeds 2200, and it is great folly to make it so great, because it is reduced to 1700 almost in an instant, by the enormous resistance.

The resistance to other balls will be made by taking them in the duplicate ratio of the diameters.

4 dif- ns of ema- not ed.

It has been already observed, that the first mathematicians of Europe have lately employed themselves in improving this theory of the motion of bodies in a resisting medium; but their discussions are such as few artillerists can understand. The problem can only be solved by approximation, and this by the quadrature of very complicated curves. They have not been able therefore to deduce from them any practical rules of easy application, and have been obliged to compute tables suited to different cases. Of these performances, that of the Chevalier Borda, in the Memoirs of the Academy of Sciences in 1769, seems the best adapted to military readers, and the tables are undoubtedly of considerable use; but it is not too much to say, that the simple rules of Mr Robins are of as much service, and are more easily remembered: besides, it must be observed, that the nature of military service does not give room for the application of any very precise rule. The only advantage that we can derive from a perfect theory would be an improvement in the construction of pieces of ordnance, and a more judicious appropriation of certain velocities to certain purposes. The service of a gun or mortar must always be regulated by the eye.

25 's and ns's ently eft.

26 ula- of air,

There is another motion of which air and other elastic fluids are susceptible, viz. an internal vibration of their particles, or undulation, by which any extended portion of air is distributed into alternate parcels of condensed and rarefied air, which are continually changing their condition without changing their places. By this change the condensation which is produced in one part of the air is gradually transferred along the mass of air to the greatest distances in all directions. It is of importance to have some distinct conception of this motion. It is found to be by this means that distant bodies produce in us the sensation of sound. See SOUND, ACOUSTICS. Sir Isaac Newton treated this subject with his accustomed ingenuity, and has given us a theory of it in the end of the second book of his *Principia*. This theory has been objected to with respect to the conduct of the argument, and other explanations have been given by the most eminent mathematicians. Though they appear to differ from Newton's, their results are precisely the same; but, on a close examination, they differ no more than John Bernouilli's theorem of centripetal forces differs from Newton's, viz. the one being expressed by geometry and the other by literal analysis. The celebrated De la Grange reduces Newton's investigation to a tautological proposition or identical equation; but Mr Young of Trinity College, Dublin, has, by a different turn of expression, freed Newton's method from this objection. We shall not repeat it here, but refer our mathematical readers to the article ACOUSTICS, it not being our business at present to consider its connection with sound. This will make the subject of a distinct article.

Undulation of Air.

But since Newton published this theory of aerial undulations, and of their propagation along the air, and since the theory has been so corrected and improved as to be received by the most accurate philosophers as a branch of natural philosophy susceptible of rigid demonstration, it has been freely resorted to by many writers on other parts of natural science, who did not profess to be mathematicians, but made use of it for explaining phenomena in their own line on the authority of the mathematicians themselves. Learning from them that this vibration, and the *quaquaversum* propagation of the pulses, were the necessary properties of an elastic fluid, and that the rapidity of this propagation had a certain assignable proportion to the elasticity and density of the fluid, they freely made use of these concessions, and have introduced elastic vibrating fluids into many facts, where others would suspect no such thing, and have attempted to explain by their means many abstruse phenomena of nature. Æthers are everywhere introduced, endued with great elasticity and tenuity. Vibrations and pulses are supposed in this æther, and these are offered as explanations. The doctrines of animal spirits and nervous fluids, and the whole mechanical system of Hartley, by which the operations of the soul are said to be explained, have their foundation in this theory of aerial undulations. If these fancied fluids, and their internal vibrations, really operate in the phenomena ascribed to them, any explanation that can be given of the phenomena from this principle must be nothing else than showing that the legitimate consequences of these undulations are similar to the phenomena; or, if we are no more able to see this last step than in the case of sound (which we know to be *one* consequence of the aerial undulations, although we cannot tell how), we must be able to point out, as in the case of sound, certain constant relations between the general laws of these undulations and the general laws of the phenomena. It is only in this way that we think ourselves intitled to say that the aerial undulations are causes, though not the only causes, of sound; and it is because there is no such relation, but, on the contrary, a total dissimilarity, to be observed between the laws of elastic undulations and the laws of the propagation of light, that we assert with confidence that ethereal undulations are not the causes of vision.

327 Has been used to explain a variety of natural phenomena.

Explanations of this kind suppose, therefore, in the first place, that the philosopher who proposes them understands precisely the nature of these undulations; in the next place, that he makes his reader sensible of those circumstances of them which are concerned in the effect to be explained; and, in the third place, that he makes the reader understand how this circumstance of the vibrating fluid is connected with the phenomenon, either by showing it to be its mechanical cause,

328 But the application not being made with sufficient precision,

Undulation of Air

as when the philosopher explains the resounding of a musical chord to a flute or pipe which gave the same tone; or by showing that this circumstance of the undulation always accompanies the phenomenon, as when the philosopher shows that 233 vibrations of air in a second, in whatever manner or by whatever cause they are produced, always are followed by the sensation of the tone C in the middle of the harpsichord.

But here we must observe, that, with the exception of Euler's unsuccessful attempt to explain the optical phenomena by the undulations of ether, we have met with no explanation of natural phenomena, by means of elastic and vibrating fluids, where the author has so much as attempted any one of these three things, so indispensably requisite in a logical explanation. They have talked of vibrations without describing them, or giving the reader the least notion of what kind they are; and in no instance that we can recollect have they showed how such vibrations could have any influence in the phenomenon. Indeed, by not describing with precision the undulations, they were freed from the task of showing them to be mechanical causes of the phenomenon; and when any of them show any analogy between the general laws of elastic undulations and the general laws of the phenomenon, the analogy is so vague, indistinct, or partial, that no person of common prudence would receive it as argument in any case in which he was much interested.

329 Has become the foundation of materialism.

We think it our duty to remonstrate against this slovenly way of writing: we would even hold it up to reprobation. It has been chiefly on this faithless foundation that the blind vanity of men has raised that degrading system of opinions called MATERIALISM, by which the affections and faculties of the soul of man have been resolved into vibrations and pulses of ether.

330 Of the motion of elastic fluids.

We also think it our duty to give some account of this motion of elastic fluids. It must be such an account as shall be understood by those who are not mathematicians, because those only are in danger of being misled by the improper application of them. Mathematical discussion is, however, unavoidable in a subject purely mathematical; but we shall introduce nothing that may not be easily understood or confided in; and we trust that mathematical readers will excuse us for a mode of reasoning which appears to them lax and inelegant.

331 How they differ from unelastic fluids in propagating any agitation of their parts.

The first thing incumbent on us is to show how elastic fluids differ from the unelastic in the propagation of any agitation of their parts. When a long tube is filled with water, and any one part of it pushed out of its place, the whole is instantly moved like a solid mass. But this is not the case with air. If a door be suddenly shut, the window at the farther end of a long and close room will rattle; but some time will elapse between the shutting of the door and the motion of the window. If some light dust be lying on a braced drum, and another be violently beat at a little distance from it, an attentive observer will see the dust dance up from the parchment; but this will be at the instant he hears the sound of the stroke on the other drum, and a sensible time after the stroke. Many such familiar facts show that the agitation is gradually communicated along the air; and therefore that when one particle is agitated by any sensible motion, a finite time, however small, must elapse before the adjoining particle is agitated in the same manner. This would not be the case in water if water be perfectly incompressible. We think that this may be made intelligible with very little trouble.

Undulation of Air

A *a* B *b* C D

Let A, B, C, D, &c. be a row of aerial particles, at such distances that their elasticity just balances the pressure of the atmosphere; and let us suppose (as is deducible from the observed density of air being proportional to the compressing force) that the elasticity of the particles, by which they keep each other at a distance, is as their distances inversely. Let us farther suppose that the particle A has been carried, with an uniform motion, to *a* by some external force. It is evident that B cannot remain in its present state; for being now nearer to *a* than to C, it is propelled towards C by the excess of the elasticity of A above the natural elasticity of C. Let E be the natural elasticity of the particles, or the force corresponding to the distance BC or BA, and let F be the force which impels B towards C, and let f be the force exerted by A when at *a*. We have

$$E : f = Ba : BC, = Ba : BA;$$
$$\text{and } E : f - E = Ba : BA - Ba = Ba : Aa;$$
$$\text{or } E : F = Ba : Aa.$$

Now in fig. 71. let ABC be the line joining three particles, to which draw FG, PH parallel, and IAF, HBG perpendicular. Take IF or HG to represent the elasticity corresponding to the distance AB. Let the particle A be supposed to have been carried with an uniform motion to *a* by some external force, and draw R*a*M perpendicular to RG, and make FI : RM = B*a* : BA. We shall then have FI : PM = B*a* : A*a*; and PM will represent the force with which the particle B is urged towards C. Suppose this construction to be made for every point of the line AB, and that a point M is thus determined for each of them, mathematicians know that all these points M lie in the curve of a hyperbola, of which FG and GH are the asymptotes. It is also known by the elements of mechanics, that since the motion of A along AB is uniform, A*a* or IP may be taken to represent the time of describing A*a*; and that the area IPM represents the whole velocity which B has acquired in its motion towards C when A has come to *a*, the force urging B being always as the portion PM of the ordinate.

Plate CCC

Take GX of any length in HG produced, and let GX represent the velocity which the uniform action of the natural elasticity IF could communicate to the particle B during the time that A would uniformly describe AB. Make GX to GY as the rectangle IFGH to the hyperbolic space IFRM, and draw YS cutting MR produced in S, and draw FX cutting MR in T. It is known to the mathematicians that the point S is in a curve line FS called the *logarithmic curve;* of which the leading property is, that any line RS parallel to GX is to GX as the rectangle IFGH is to the hyperbolic space IFRM, and that FX touches the curve in F.

This being the case, it is plain, that because RT increases in the same proportion with FR, or with the rectangle IFRP, and RS increases in the proportion of the space IFRM, TS increases in the proportion of the space IPM. Therefore TS is proportional to the velocity of B when A has reached *a*, and RT is pro-

[Undul]ation of Air. proportional to the velocity which the uniform action of the natural elaſticity would communicate to B in the ſame time. Then ſince FT is as the time, and TS is as the velocity, the area FTS will be as the ſpace deſcribed by B (urged by the variable force PM); while A, urged by the external force, deſcribes A *a*; and the triangle FRT will repreſent the ſpace which the uniform action of the natural elaſticity would cauſe B to deſcribe in the ſame time.

And thus it is plain that theſe three motions can be compared together: the uniform motion of the agitated particle A, the uniformly accelerated motion which the natural elaſticity would communicate to B by its conſtant action, and the motion produced in B by the agitation of A. But this compariſon, requiring the quadrature of the hyperbola and logarithmic curve, would lead us into moſt intricate and tedious computations. Of theſe we need only give the reſult, and make ſome other compariſons which are palpable.

Let A *a* be ſuppoſed indefinitely ſmall in compariſon of AB. The ſpace deſcribed by A is therefore indefinitely ſmall; but in this caſe we know that the ratio of the ſpace FRT to the rectangle IFRP is indefinitely ſmall. There is therefore no compariſon between the agitation of A by the external force, and the agitation which natural elaſticity would produce on a ſingle particle in the ſame time, the laſt being incomparably ſmaller than the firſt. And this ſpace FRT is incomparably greater than FTS; and therefore the ſpace which B would deſcribe by the uniform action of the natural elaſticity is incomparably greater than what it would deſcribe in conſequence of the agitation of A.

From this reaſoning we ſee evidently that A muſt be ſenſibly moved, or a finite or meaſurable time muſt elapſe before B acquires a meaſurable motion. In like manner B muſt move during a meaſurable time before C acquires a meaſurable motion, &c.; and therefore the agitation of A is communicated to the diſtant particles in gradual ſucceſſion.

By a farther compariſon of theſe ſpaces we learn the time in which each ſucceeding particle acquires the very agitation of A. If the particles B and C only are conſidered, and the motion of C neglected, it will be found that B has acquired the motion of A a little before it has deſcribed $\frac{1}{2}$ of the ſpace deſcribed by A; but if the motion of C be conſidered, the acceleration of B muſt be increaſed by the retreat of C, and B muſt deſcribe a greater ſpace in proportion to that deſcribed by A. By computation it appears, that when both B and C have acquired the velocity of A, B has deſcribed nearly $\frac{1}{2}$ of A's motion, and C more nearly $\frac{1}{2}$. Extending this to D, we ſhall find that D has deſcribed ſtill more nearly $\frac{1}{2}$ of A's motion. And from the nature of the computation it appears that this approximation goes on rapidly: therefore, ſuppoſing it accurate from the very firſt particle, it follows from the equable motion of A, that each ſucceeding particle moves through an equal ſpace in acquiring the motion of A.

The concluſion which we muſt draw from all this is, that when the agitation of A has been fully communicated to a particle at a *ſenſible* diſtance, the intervening particles, all moving forward with a common velocity, are equally compreſſed as to ſenſe, except a very few of the firſt particles; and that this communication, or this propagation of the original agitation, goes on with an uniform velocity.

Theſe computations need not be attended to by ſuch as do not wiſh for an accurate knowledge of the preciſe agitation of each particle. It is enough for ſuch readers to ſee clearly that time *muſt* eſcape between the agitation of A and that of a diſtant particle; and this is abundantly manifeſt from the incomparability (excuſe the term) of the naſcent rectangle IFRP with the naſcent triangle FRT, and the incomparability of FRT with FTS.

What has now been ſhown of the communication of any ſenſible motion A *a* muſt hold equally with reſpect to any change of this motion. Therefore if a tremulous motion of a body, ſuch as a ſpring or bell, ſhould agitate the adjoining particle A by puſhing it forward in the direction AB, and then allowing it to come back again in the direction BA, an agitation ſimilar to this will take place in all the particles of the row 332
Newton's demonſtration on this ſubject juſt as far as it goes;
one after the other. Now if this body vibrate according to the law of motion of a pendulum vibrating in a cycloid, the neighbouring particle of air *will of neceſſity* vibrate in the ſame manner; and then Newton's demonſtration in art. Acoustics needs no apology. Its only deficiency was, that it *ſeemed* to prove that this *would be* the way in which every particle would of neceſſity vibrate; which is not true, for the ſucceſſive parcels of air will be differently agitated according to the original agitation. Newton only wants to prove the uniform propagation of the agitations, and he ſelects that form which renders the proof eaſieſt. He proves, in the moſt unexceptionable manner, that if the particles of a pulſe of air are really moving like a cycloidal pendulum, the forces acting on each particle, in conſequence of the compreſſion and dilatation of the different parts of the pulſe, are preciſely ſuch as are neceſſary for continuing this motion, and therefore no other forces are required. Then ſince each particle is in a certain part of its path, is moving in a certain direction, and with a certain velocity, and urged by a determined force, it *muſt* move in that very manner. The objection ſtarted by John Bernouilli againſt Newton's demonſtration (in a ſingle line) of the elliptical motion of a body urged by a force in the inverſe duplicate ratio of the diſtance from the focus, is preciſely the ſame with the objection againſt Newton's demonſtration of the progreſs of aerial undulations, and is equally futile.

It muſt, however, be obſerved, that Newton's demonſtration proceeds on the ſuppoſition that the linear agitations of a particle are incomparably ſmaller than the extent of an undulation. This is not ſtrictly the caſe in any inſtance, and in many it is far from being true. In a pretty ſtrong twang of a harpſichord-wire, the agitation of a particle may be near the 50th part of the extent of the undulation. This muſt diſturb the regularity of the motion, and cauſe the agitations in the remote undulations to differ from thoſe in the firſt pulſe. In the exploſion of a cannon, the breaking of an exhauſted bottle, and many inſtances which may be given, the agitations are ſtill greater. The commentators on Newton's *Principia*, Le Sueur and Jacquier, have ſhown, and Euler more clearly, that when the original agitations are very violent, the particles of air will acquire a ſubordinate vibration compounded with the regular cycloidal vibration, and the progreſs of the pulſes will be ſomewhat more rapid; but the intricacy of the calculus is ſo great, that they have not been able to determine with any tolerable preciſion what the change of velocity will be.

Undulation of Air.

333 It is strengthened by comparing the sound of a cannon near and at a distance.

All this, however, is fully confirmed by experiment on sounds. The sound of a cannon at 10 or 20 miles distance does not in the least resemble its sound when near. In this case it is a loud instantaneous crack, to which we can assign no musical pitch: at a distance, it is a grave sound, of which we can tell the note; and it begins softly, swells to its greatest loudness, and then dies away growling. The same may be said of a clap of thunder, which we know to be a loud snap of still less duration. It is highly probable that the appreciable tone which those distant sounds afford are produced by the continuance of these subordinate vibrations which are added together and fortified in the successive pulses, though not perceptible in the first, in a way somewhat resembling the resonance of a musical chord. Newton's explanation gathers evidence therefore from this circumstance. And we must further observe, that all elastic bodies tremble or vibrate almost precisely as a pendulum swinging in a cycloid, unless their vibrations are uncommonly violent; in which case they are quickly reduced to a moderate quantity by the resistance of the air. The only very loud sounds which we can produce in this way are from great bells; and in these the utmost extent of the vibration is very small in comparison with the breadth of the pulse. The velocity of these sounds has not been compared with that of cannon, or perhaps it would be found less, and an objection against Newton's determination removed. He gives 969 feet per second, Experiment 1142.

334 The agitation in all probability in the successive pulses assumes a cycloidal form.

But it is also very probable, that in the propagation through the air, the agitation gradually and rapidly approaches to this regular cycloidal form in the successive pulses, in the same way as we observe that whatever is the form of agitation in the middle of a smooth pond of water, the spreading circles are always of one gentle form without asperities. In like manner, into whatever form we throw a stretched cord by the twang which we give it, it almost immediately makes smooth undulations, keeping itself in the shape of an elongated trochoid. Of this last we can demonstrate the necessity, because the case is simple. In the wave, the investigation is next to impossible; but we see the fact. We may therefore presume it in air. And accordingly we know that any noise, however abrupt and jarring, near at hand, is smooth at a distance. Nothing is more rough and harsh than the scream of a heron; but at half a mile's distance it is soft. The ruffle of a drum is also smooth at a distance

Plate CCCCVI.

Fig. 72. shows the successive situations of the particles of a row. Each line of the figure shows the same particles marked with the same letters; the first particle *a* being supposed to be removed successively from its quiescent situation and back to it again. The mark × is put on that part of each line where the agitated particles are at their natural distances, and the air is of the natural density. The mark 1 is put where the air is most of all compressed, and : where it is most of all dilated; the curve line drawn through the lowest line of the figure is intended to represent the density in every point, by drawing ordinates to it from the straight line: the ordinates below the line indicate a rarity, and those above the line a density, greater than common.

It appears that when *a* has come back to its natural situation, the part of greatest density is between the particles *i* and *k*, and the greatest rarity between *c* and *d*.

We have only to add, that the velocity of this propagation depends on the elasticity and density of the fluid. If these vary in the same proportion, that is, if the fluid has its elasticity proportional to its density, the velocity will remain the same. If the elasticity or density alone be changed, the velocity of the undulations will change in the direct subduplicate ratio of the elasticity and the inverse subduplicate ratio of the density; for should the elasticity be quadrupled, the quantity of motion produced by it in any given time will be quadrupled. This will be the case if the velocity be doubled; for there would then be double the number of particles doubly agitated. Should the density be quadrupled, the elasticity remaining the same, the quantity of motion must remain the same. This will be the case if the velocity be reduced to one half; for this will propagate half the agitation to half the distance, which will communicate it to twice the number of particles, and the quantity of motion will remain the same. The same may be said of other proportions, and therefore $V = \frac{\sqrt{E}}{\sqrt{D}}$. Therefore a change in the barometer will not affect the velocity of the undulations in air, but they will be accelerated by heat, which diminishes its density, or increases its elasticity. The velocity of the pulses in inflammable air must be at least thrice as great, because its density is but one-tenth of that of air when the elasticity of both are the same.

Undulation of Air.

335 Further consideration of aerial pulses as they really occur.

Let us now attend a little to the propagation of aerial pulses as they really happen; for this hypothesis of a single row of particles is nowhere to be observed.

Suppose a sphere A, fig. 73. filled with condensed air, and that the vessel which contains it is suddenly annihilated. The air must expand to its natural dimensions, suppose BCD. But it cannot do this without pressing aside the surrounding air. We have seen that in any single row of particles this cannot be at once diffused to a distance, but must produce a condensation in the air adjoining; which will be gradually propagated to a distance. Therefore this sphere BCD of the common density will form round it a shell, bounded by EFG, of condensed air. Suppose that at this instant the inner air BCD becomes solid. The shell of condensed air can expand only outwards. Let it expand till it is of the common density, occupying the shell HIK. This expansion, in like manner, must produce a shell of condensed air without it: at this instant let HIK become solid. The surrounding shell of condensed air can expand only outward, condensing another shell without it. It is plain that this must go on continually, and the central agitation will be gradually propagated to a distance in all directions. But, in this process, it is not the same numerical particles that go to a distance. Those of the original sphere go no further than BCD, those of the next shell go no further than HIK, &c. Farther, the expansion outwards of any particle will be more moderate as the diffusion advances; for the whole motion of each shell cannot exceed the original quantity of motion; and the number of particles in each successive shell increases as the surface, that is, as the square of the distance from the centre: therefore the agitation of the particles will decrease in the same ratio, or will be in the inverse duplicate ratio of the distance from the centre. Each successive shell, therefore, contains the same quantity of motion, and the successive agitations of the particles of any row.

8

...ation ...ir.

row out from the centre will not be equal to the original agitation, as happens in the solitary row. But this does not affect the velocity of the propagation, because all agitations are propagated equally fast.

We supposed the air A to become solid as soon as it acquired the common density; but this was to facilitate the conception of the diffusion. It does not stop at this bulk; for while it was denser it had a tendency to expand. Therefore each particle has attained this distance with an accelerated motion. It will, therefore, continue this motion like a pendulum that has passed the perpendicular, till it is brought to rest by the air without it; and it is now rarer than common air, and collapses again by the greater elasticity of the air without it. This outward air, therefore, in regaining its natural density, must expand both ways. It expands towards the centre, following the collapsing of the air within it; and it expands outwards, condensing the air beyond it. By expanding inwards, it will again condense the air within it, and this will again expand; a similar motion happens in all the outward shells; and thus there is propagated a succession of condensed and rarefied shells of air, which gradually swell to the greatest distance.

It may be demonstrated, that when the central air has for the second time acquired the natural density, it will be at rest, and be disturbed no more; and that this will happen to all the shells in succession. But the demonstration is much too intricate for this place; we must be contented with pointing out a fact perfectly analogous. When we drop a small pebble into water, we see it produce a series of circular waves, which go along the surface of smooth water to a great distance, becoming more and more gentle as they recede from the centre; and the middle, where the agitation was first produced, remains perfectly smooth, and this smoothness extends continually; that is, each wave when brought to a level remains at rest. Now these waves are produced and propagated by the depression and elevation made at the centre. The elevation tends to diffuse itself; and the force with which each particle of water is actuated is a force acting directly up and down, and is proportional to the elevation or depression of the particle. This hydrostatical pressure operates precisely in the same way as the condensation and rarefaction of the air; and the mathematical investigation of the propagation of the circular undulations on smooth water is similar in every step to that of the propagation of the spherical waves in still air. For this we appeal to Newton's *Principia*, or to Euler's *Opuscula*, where he gives a very beautiful investigation of the velocity of the aerial pulses; and to some memoirs of de la Grange in the collections of the academies of Berlin and Turin. These two last authors have made the investigation as simple as seems possible, and have freed it from every objection which can be stated against the geometrical one of their great teacher Newton.

...6 ...cation ...e fact ...pping ...ble ...water.

Having said this much on the similarity between the waves on water and the aerial undulations, we shall have recourse to them, as affording us a very sensible object to represent many affections of the other which it would be extremely difficult to explain. We neither see nor feel the aerial undulations; and they behoved, therefore, to be described very abstractedly and imperfectly. In the watery wave there is no permanent progressive motion of the water from the centre. Throw a small bit of cork on the surface, and it will be observed to popple up and down without the least motion outwards. In like manner, the particles of air are only agitated a very little outwards and inwards; which motion is communicated to the particles beyond them, while they themselves come to rest, unless agitated afresh; and this agitation of the particles is inconceivably small. Even the explosion of a cannon at no great distance will but gently agitate a feather, giving it a single impulse outwards, and immediately after another inwards or towards the cannon. When a harpsichord wire is forcibly twanged at a few feet distance, the agitation of the air is next to insensible. It is not, however, nothing; and it differs from that in a watery wave by being *really* outwards and inwards. In consequence of this, when the condensed shell reaches an elastic body, it impels it slightly. If its elasticity be such as to make it acquire the opposite shape at the instant that the next agitation and condensed shell of air touches it, its agitation will be doubled, and a third agitation will increase it, and so on, till it acquire the agitation competent to that of the shell of air which reaches it, and it is thrown into *sensible* vibration, and gives a sound extremely faint indeed, because the agitation which it acquires is that corresponding to a shell of air considerably removed from the original string. Hence it happens that a musical chord, pipe, or bell, will cause another to resound, whose vibrations are isochronous with its own; or if the vibrations of the one coincides with every second, or third, or fourth, &c. of the other; just as we can put a very heavy pendulum into sensible motion by giving it a gentle puff with the breath at every vibration, or at every second, third, or fourth, &c. A drum struck in the neighbourhood of another drum will agitate it *very sensibly*; for here the stroke depresses a very considerable surface, and produces an agitation of a considerable mass of air: it will even agitate the surface of stagnant water. The explosion of a cannon will even break a neighbouring window. The shell of condensed air which comes against the glass has a great surface and a great agitation: the best security in this case is to throw up the sash; this admits the condensed air into the room, which acts on the inside of the window, balancing part of the external impulse.

...7 waves ...ter ...seful ...xplain ...hose ...

Undulation of Air.

It is demonstrated in every elementary treatise of natural philosophy, that when a wave on water meets any plane obstacle, it is reflected by it from a centre equally removed behind the obstacle; that waves radiating from the focus of a parabola are reflected in waves perpendicular to its axis; that waves radiating from one focus of an ellipse are made to converge to the other focus, &c. &c. All this may be affirmed of the aerial undulations; that when part of a wave gets through a hole in the obstacle, it becomes the centre of a new series of waves; that waves bend round the extremities of an obstacle: all this happens in the aerial undulations. And lastly, that when the surface of water is thrown into regular undulations by one agitation, another agitation in another place will produce other regular waves, which will cross the former without disturbing them in the smallest degree. The same thing happens in air; and experiments may be made on water which will illustrate in the most perfect manner many other affections of the aerial pulses, which we should otherwise conceive very imperfectly. We would recom-

338 For waves of air and of water are in many respects very similar.

Undulation of Air.

recommend to our curious readers to make some of these experiments in a large vessel of milk. Take a long and narrow plate of lead, which, when set on the bottom of the vessel will reach above the surface of the milk; bend this plate into a parabola, elliptical or other curve. Make the undulations by dropping milk on the focus from a small pipe, which will cause the agitations to succeed with rapidity, and then all that we have said will be most distinctly seen, and the experiment will be very amusing and instructive, especially to the musical reader.

339 Caution to the supporters of æthers, animal spirits, &c.

We would now request all who make or read explanations of natural phenomena by means of vibrations of ethers, animal spirits, nervous fluids, &c. to fix their attention on the nature of the agitation in one of these undulations. Let him consider whether this can produce the phenomenon, acting as any matter must act, by impulse or by pressure. If he sees that it can produce the phenomenon, he will be able to point out the very motion it will produce, both in quantity and direction, in the same manner as Sir Isaac Newton has pointed out all the irregularities of the moon's motion produced by the disturbing force of the sun. If he cannot do this, he fails in giving the first evidence of a mechanical explanation by the action of an elastic vibrating fluid. Let him then try to point out some palpable connection between the general phenomena of elastic undulations and the phenomenon in question; this would show an accompaniment to have at least some probability. It is thus only we learn that the undulations of air produce sound: we cannot tell how they affect the mechanism of the ear; but we see that the phenomena of sound always accompany them, and that certain modifications of the one are regularly accompanied by certain modifications of the other. If we cannot do this neither, we have derived neither explanation nor illustration from the elastic fluid. And lastly, let him remember that even if he should be able to show the competency of this fluid to the production of the phenomenon, the whole is still an hypothesis, because we do not know that such a fluid exists.

340 The folly of appealing to such unknown substances.

We will venture to say, that whoever will proceed in this prudent manner will soon see the futility of most of the explanations of this kind which have been given. They are unfit for any but consummate mathematicians; for they alone really understand the mechanism of aerial undulations, and even they speak of them with hesitation as a thing but imperfectly understood. But even the unlearned in this science can see the incompatibility of the hypotheses with many things which they are brought to explain. To take an instance of the conveyance of sensation along the nerves; an elastic fluid is supposed to occupy them, and the undulations of this fluid are thought to be propagated along the nerves. Let us just think a little how the undulations would be conveyed along the surface of a canal which was completely filled up with reeds and bulrushes, or let us make the experiment on such a canal: we may rest assured that the undulations in the one case will resemble those in the other; and we may see that in the canal there will be no regular or sensible propagation of the waves.

Let these observations have their influence, along with others which we have made on other occasions, to wean our readers from this fashionable proneness to introduce invisible fluids and unknown vibrations into our physical discussions. They have done immense, and we fear irreparable, mischief in science; and there is but one phenomenon that has ever received any explanation by their means.

Air's pressure.

This may suffice for a loose and popular account of aerial undulations; and with it we conclude our account of the motion, impulse, and resistance of air.

We shall now explain a number of natural appearances, depending on its pressure and elasticity, appearances not sufficiently general, or too complicated for the purposes of argument, while we were employed in the investigation of these properties, but too important to be passed over in silence.

34[1] The air's pressure occasions cohesion of two surfaces accurately fitting each other.

It is owing to the pressure of the atmosphere that two surfaces which accurately fit each other cohere with such force. This is a fact familiarly known to the glass-grinders, polishers of marble, &c. A large lense or speculum, ground on its tool till it becomes very smooth, requires more than any man's strength to separate it directly from the tool. If the surface is only a square inch, it will require 15 pounds to separate them perpendicularly, though a very moderate force will make them slide along each other. But this cohesion is not observed unless the surfaces are wetted or smeared with oil or grease; otherwise the air gets between them, and they separate without any trouble. That this cohesion is owing to the atmospheric pressure, is evident from the ease with which the plates may be separated in an exhausted receiver.

34[2] And the adhesion of snails, &c. to rocks.

To the same cause we must ascribe the very strong adhesion of snails, periwinkles, limpets, and other univalve shells, to the rocks. The animal forms the rim of its shell, so as to fit the shape of the rock to which it intends to cling. It then fills its shell (if not already filled by its own body) with water. In this condition it is evident that we must act with a force equal to 15 pounds for every square inch of touching surface before we can detach it. This may be illustrated by filling a drinking glass to the brim with water; and having covered it with a piece of thin wet leather, whelm it on a table, and then try to pull it straight up; it will require a considerable force. But if we expose a snail adhering to a stone in the exhausted receiver, we shall see it drop off by its own weight. In the same manner do the remora, the polypus, the lamprey, and many other animals, adhere with such firmness. Boys frequently amuse themselves by pulling out large stones from the pavement by means of a circle of stiff wetted leather fastened to a string. It is owing to the same cause that the bivalve shell fishes keep themselves so firmly shut. We think the muscular force of an oyster prodigious, because it requires such force to open it; but if we grind off a bit of the convex shell, so as to make a hole in it, though without hurting the fish in the smallest degree, it opens with great ease, as it does also *in vacuo*.

34[3] Other effects of the air's pressure.

The pressure of the air, operating in this way contributes much to the cohesion of bodies, where we do not suspect its influence. The tenacity of our mortars and cements would frequently be ineffectual without this assistance.

It is owing to the pressure of the atmosphere that a cask will not run by the cock unless a hole be opened in some other part of the cask. If the cask is not quite

full, ſome liquor indeed will run out, but it will ſtop as ſoon as the diminiſhed elaſticity of the air above the liquor is in equilibrio (together with the liquor) with the atmoſpheric preſſure. In like manner, a teapot muſt have a ſmall hole in its lid to enſure its pouring out the tea. If indeed the hole in the caſk is of large dimenſions, it will run without any other hole, becauſe air will get in at the upper ſide of the hole while the liquor runs out by the lower part of it.

On the ſame principle depends the performance of an inſtrument uſed by the ſpirit dealers for taking out a ſample of their ſpirits. It conſiſts of a long tinplate tube AB (fig. 57.), open atop at A, and ending in a ſmall hole at B. The end B is dipped into the ſpirits, which riſes into the tube; then the thumb is clapt on the mouth A, and the whole is lifted out of the caſk. The ſpirit remains in it till the thumb be taken off; it is then allowed to run into a glaſs for examination.

It ſeems principally owing to the preſſure of the air that froſts immediately occaſion a ſcantineſs of water in our fountains and wells. This is erroneouſly accounted for, by ſuppoſing that the water freezes in the bowels of the earth. But this is a great miſtake: the moſt intenſe froſt of a Siberian winter would not freeze the ground two feet deep; but a very moderate froſt will conſolidate the whole ſurface of a country, and make it impervious to the air; eſpecially if the froſt has been preceded by rain, which has ſoaked the ſurface. When this happens, the water which was filtering through the ground is all arreſted and kept ſuſpended in its capillary tubes by the preſſure of the air, in the very ſame manner as the ſpirits are kept ſuſpended in the inſtrument juſt now deſcribed by the thumb's ſhutting the hole A. A thaw melts the ſuperficial ice, and allows the water to run in the ſame manner as the ſpirits run when the thumb is removed.

Common air is neceſſary for ſupporting the lives of moſt animals. If a ſmall animal, ſuch as a mouſe or bird, be put under the receiver of an air-pump, and the air be exhauſted, the animal will quickly be thrown into convulſions and fall down dead; if the air be immediately readmitted, the animal will ſometimes revive, eſpecially if the rarefaction has been briſkly made, and has not been very great. We do not know that any breathing animal can bear the air to be reduced to $\frac{1}{4}$ of its ordinary denſity, nor even $\frac{1}{3}$; nor have we good evidence that an animal will ever recover if the rarefaction is puſhed very far, although continued for a very ſhort time.

But the mere preſence of the air is by no means ſufficient for preſerving the life of the animal; for it is found, that an animal ſhut up in a veſſel of air cannot live in it for any length of time. If a man be ſhut up in a box, containing a wine hogſhead of air, he cannot live in it much above an hour, and long before this he will find his breathing very unſatisfactory and uneaſy. A gallon of air will ſupport him about a minute. A box EF (fig. 58.) may be made, having a pipe AB inſerted into its top, and fitted with a very light valve at B, opening upwards. This pipe ſends off a lateral branch *a* D *d* C, which enters the box at the bottom, and is alſo fitted with a light valve at C opening upwards. If a perſon breathe through the pipe, keeping his noſtrils ſhut, it is evident that the air which he expires will not enter the box by the hole B, nor return through the pipe CD *d*; and by this contrivance he will gradually employ the whole air of the box. With this apparatus experiments can be made without any riſk or inconveniency, and the quantity of air neceſſary for a given time of eaſy breathing may be accurately aſcertained.

Effects of Air's preſſure.

How the air of our atmoſphere produces this effect, is a queſtion which does not belong to mechanical philoſophy to inveſtigate or determine. We can, however, affirm, that it is neither the preſſure nor the elaſticity of the air which is immediately concerned in maintaining the animal functions. We know that we can live and breathe with perfect freedom on the tops of the higheſt mountains. The valley of Quito in Peru, and the country round Gondar in Abyſſinia, are ſo far elevated above the ſurface of the ocean, that the preſſure and the elaſticity of the air are one-third leſs than in the low countries; yet theſe are populous and healthy places. And, on the other hand, we know, that when an animal has breathed in any quantity of air for a certain time without renewal, it will not only be ſuffocated, but another animal put into this air will die immediately; and we do not find either the preſſure or elaſticity of the air remarkably diminiſhed: it is indeed diminiſhed, but by a very ſmall quantity. Reſtoring the former preſſure and elaſticity has not the ſmalleſt tendency to prevent the death of the animal: for an animal will live no longer under a receiver that has its mouth inverted on water, than in one ſet upon the pump-plate covered with leather. Now when the receiver is ſet on water, the preſſure of the atmoſphere acts completely on the included air, and preſerves it in the ſame ſtate of elaſticity.

346 The nature of air when it has maintained animal functions is quite altered.

In ſhort, it is known that the air which has already ſerved to maintain the animal functions has its chemical and alimentary properties completely changed, and is no longer fit for this purpoſe. So much of any maſs of air as has really been thus employed is changed into what is called *fixed air* by Dr Black, or *carbonic acid* by the chemiſts of the Lavoiſierian ſchool. Any perſon may be convinced of this by breathing or blowing through a pipe immerſed in lime water. Every expiration will produce white clouds on the water, till all the lime which it contains is precipitated in the form of pure chalk. In this caſe we know that the lime has combined with the fixed air.

347 Hales's experiments to reſtore its former qualities, &c.

The celebrated Dr Stephen Hales made many experiments, with a view to clear the air from the noxious vapour which he ſuppoſed to be emitted from the lungs. He made uſe of the apparatus which we have been juſt now mentioning; and he put ſeveral diaphragms *ff ff*, &c. of thin woollen ſtuff into the box, and moiſtened them with various liquids. He found nothing ſo efficacious as a ſolution of potaſh. We now underſtand this perfectly. If the ſolution is not already ſaturated with fixed air, it will take it up as faſt as it is produced, and thus will purify the air: a ſolution of cauſtic alkali therefore will have this effect till it is rendered quite mild.

348 How it comes to be changed by breathing, and the nature of inſpiration, the &c.

Theſe experiments have been repeated, and varied in many circumſtances, in order to aſcertain whether this fixed air was really emitted by the lungs, or whether the inſpired air was in part changed into fixed air by its combination with ſome other ſubſtance. This is a queſtion which comes properly in our way, and which

Effects of Air's pressure.

the doctrines of pneumatics enable us to answer. If the fixed air be emitted in substance from the lungs, it does not appear how a renewal of the air into which it is emitted is necessary: for this does not hinder the subsequent emission; and the bulk of the air would be increased by breathing in it, viz. by the bulk of all the fixed air emitted; but, on the contrary, it is a little diminished. We must therefore adopt the other opinion; and the discoveries in modern chemistry enable us to give a pretty accurate account of the whole process. Fixed air is acknowledged to be a compound, of which one ingredient is found to constitute about $\frac{1}{8}$ of the whole atmospheric fluid; we mean vital air or the oxygene of Lavoisier. When this is combined with phlogiston, according to the doctrine of Stahl, or with charcoal, according to Lavoisier, the result is fixed air or carbonic acid. The change therefore which breathing makes on the air is the solution of this matter by vital air; and the use of air in breathing is the carrying off this noxious principle in the way of solution. When therefore the air is already so far saturated as not to dissolve this substance as fast as it is secreted, or must be secreted in the lungs, the animal suffers the pain of suffocation, or is otherwise mortally affected. Suffocation is not the only consequence; for we can remain for a number of seconds without breathing, and then we begin to feel the true pain of suffocation; but those who have been instantaneously struck down by an inspiration of fixed air, and afterwards recovered to life, complained of no such pain, and seemed to have suffered chiefly by a nervous affection. It is said (but we will not vouch for the truth of it), that a person may safely take a full inspiration of fixed air, if the passages of the nose be shut; and that unless these nerves are stimulated by the fixed air, it is not instantaneously mortal. But these are questions out of our present line of inquiry. They are questions of physiology, and are treated of in other places of this work. See ANATOMY and PHYSIOLOGY; see also LUNGS and RESPIRATION. Our business is to explain in what manner the pressure and elasticity of the air, combined with the structure and mechanism of the body, operate in producing this necessary secretion and removal of the matter discharged from the lungs in the act of breathing.

It is well ascertained, that the secretion is made from the mass of blood during its passage through the lungs. The blood delivered into the lungs is of a dark blackish colour, and it is there changed into a florid red. In the lungs it is exposed to the action of the air in a prodigiously extended surface: for the lungs consist of an inconceivable number of small vessels or bladders, communicating with each other and with the windpipe. These are filled with air in every inspiration. These vessels are everywhere in contact with minute blood-vessels. The blood does not *in toto* come into immediate contact with the air; and it would seem that it is only the thin serous part of it which is acted on by the air at the mouths of the vessels or pores, where it stands by capillary attraction. Dr Priestley found, that venous blood inclosed in thin bladders and other membranes was rendered florid by keeping the bladders in contact with abundance of pure vital air. We know also, that breath is moist or damp, and *must* have acquired this moisture in the lungs. It is immaterial whether this secretion of water or lymph (as the anatomists call it) be furnished by mere exudation through simple pores, or by a vascular and organic secretion; in either case, some ingredient of the blood comes in contact with air in the lungs, and there unites with it. This is farther confirmed, by observing, that all breathing animals are warmer than the surrounding medium, and that by every process in which fixed air is formed from vital air heat is produced. Hence this solution in air of something from the blood has been assigned by many as the source of animal heat. We touch on these things in a very transitory way in this place, only in order to prove that, for the support of animal life, there must be a very extensive application of air to the blood, and that this is made in the lungs.

The question before us in this place is, How is this brought about by the weight and elasticity of the air? This is done in two ways; by the action of the muscles of the ribs, and by the action of the diaphragm and other muscles of the abdomen. The thorax or chest is a great cavity, completely filled by the lungs. The sides of this cavity are formed by the ribs. These are crooked or arched, and each is moveable round its two ends, one of them being inserted into the vertebræ of the back, and the other into the sternum or breast-bone. The rib turns in a manner resembling the handle of a drawer. The inspection of fig. 59. will illustrate this matter a little. Suppose the curves *a c e*, *b k f*, *c l g*, &c. to represent the ribs moveable round the extremities. Each succeeding rib is more bent than the one above it, and this curvature is both in the vertical and horizontal direction. Suppose each so broad as to project a little over its inferior like the tiles of a roof. It is evident, that if we take the lower one by its middle, and draw it out a little, moving it round the line *n p*, it will bring out the next *d m h* along with it. Also, because the distance of the middle point *o* from the axis of motion *n p* is greater than the distance of *m* from the axis *d h*, and because *o* will therefore describe a portion of a larger circle than *m* does, the rib *n o p* will slide up a little under the rib *d m h*, or the rib *d m h* will overlap *n o p* a little more than before; the distance *o m* will therefore be diminished. The same must happen to all the superior ribs; but the change of distance will be less and less as we go upwards. Now, instead of this great breadth of the ribs overlapping each other, suppose each inferior rib connected with the one above it by threads or fibres susceptible of contraction at the will of man. The articulations *e*, *a*, of the first or upper rib with the spine and sternum are so broad and firm, that this rib can have little or no motion round the line *a e*; this rib therefore is as a fixture for the ends of all the contracting fibres; therefore, whenever the fibres which connect the second rib with the first rib contract, the second must rise a little, and also go outward, and will carry the lower ribs along with it; the third rib will rise still farther by the contraction of the muscles which connect it with the second, and so on: and thus the whole ribs are raised and thrown outward (and a little forward, because the articulation of each with the spine is considerably higher than that with the sternum), and the capacity of the thorax is enlarged by the contraction of its muscular covering. The direction of the muscular fibres is very oblique to the direction of the circular motion which it produces; from which circumstance it follows, that a very minute contraction of the muscles,

muſcles produces all the motion which is neceſſary. This indeed is not great; the whole motion of the loweſt ribs is leſs than an inch in the moſt violent inſpiration, and the whole contraction of the muſcles of the 12 ribs does not exceed the eighth part of an inch, even ſuppoſing the intercoſtal muſcles at right angles to the ribs; and being oblique, the contraction is ſtill leſs (ſee Borelli, Sabatier, Monro, &c.) It would ſeem, that the intenſity of the contractive power of a muſcular fibre is eaſily obtained, but that the ſpace through which it can be exerted is very limited; for in moſt caſes nature places the muſcles in ſituations of great mechanical diſadvantage in this reſpect, in order to procure other conveniences.

But this is not the whole effect of the contraction of the intercoſtal muſcles: ſince the compound action of the two ſets of muſcles, which croſs each other from rib to rib like the letter X, is nearly at right angles to the rib, but is oblique to its plane, it tends to puſh the ribs cloſer on their articulations, and thus to preſs out the two pillars on which they are articulated. Thus, ſuppoſing *a f* (fig. 60.) to repreſent the ſection of one of the vertebræ of the ſpine, and *c d* a ſection of the ſternum, and *a b c*, *f e d*, two oppoſite ribs, with a lax thread *b e* connecting them. If this thread be pulled upwards by the middle *g* till it is tight, it will tend to pull the points *b* and *e* nearer to each other, and to preſs the vertebra *a f* and the ſternum *c d* outwards. The ſpine being the chief pillar of the body, may be conſidered as immoveable in the preſent inſtance. The ſternum is ſufficiently ſuſceptible of motion for the preſent purpoſe. It remains almoſt fixed atop at its articulation with the firſt rib, but it gradually yields below; and thus the capacity of the thorax is enlarged in this direction alſo. The whole enlargement of the diameters of the thorax during inſpiration is very ſmall, not exceeding the fiftieth part of an inch in ordinary caſes. This is eaſily calculated. Its quieſcent capacity is about two cubic feet, and we never draw in more than 15 inches. Two ſpheres, one of which holds 2 cubic feet and the other 2 feet and 15 inches, will not differ in diameter above the fiftieth part of an inch.

The other method of enlarging the capacity of the thorax is very different. It is ſeparated from the abdomen by a ſtrong muſcular partition called the *diaphragm*, which is attached to firm parts all around. In its quieſcent or relaxed ſtate it is conſiderably convex upwards, that is, towards the thorax, riſing up into its cavity like the bottom of an ordinary quart bottle, only not ſo regular in its ſhape. Many of its fibres tend from its middle to the circumference, where they are inſerted into firm parts of the body. Now ſuppoſe theſe fibres to contract. This muſt draw down its middle, or make it flatter than before, and thus enlarge the capacity of the thorax.

Phyſiologiſts are not well agreed as to the ſhare which each of theſe actions has in the operation of enlarging the thorax. Many refuſe all ſhare of it to the intercoſtal muſcles, and ſay that it is performed by the diaphragm alone. But the fact is, that the ribs are really obſerved to riſe even while the perſon is aſleep; and this cannot poſſibly be produced by the diaphragm, as theſe anatomiſts aſſert. Such an opinion ſhows either ignorance or neglect of the laws of pneumatics. If the capacity of the thorax were enlarged only by drawing down the diaphragm, the preſſure of the air would compreſs the ribs, and make them deſcend. And the ſimple laws of mechanics make it as evident as any propoſition in geometry, that the contraction of the intercoſtal muſcles *muſt* produce an elevation of the ribs and enlargement of the thorax; and it is one of the moſt beautiful contrivances of nature. It depends much on the will of the animal what ſhare each of theſe actions ſhall have. In general, the greateſt part is done by the diaphragm; and any perſon can breathe in ſuch a manner that his ribs ſhall remain motionleſs; and, on the contrary, he can breathe almoſt entirely by raiſing his cheſt. In the firſt method of breathing, the belly riſes during inſpiration, becauſe the contraction of the diaphragm compreſſes the upper part of the bowels, and therefore ſqueezes them outwards; ſo that an ignorant perſon would be apt to think that the breathing was performed by the belly, and that the belly is inflated with the air. The ſtrait lacing of the women impedes the motion of the ribs, and changes the natural habit of breathing, or brings on an unnatural habit. When the mind is depreſſed, it is obſerved that the breathing is more performed by the muſcles of the thorax; and a deep ſigh is always made in this way.

Effects of Air's preſſure.

Theſe obſervations on the manner in which the capacity of the cheſt can be enlarged were neceſſary, before we can acquire a juſt notion of the way in which the mechanical properties of air operate in applying it to the maſs of blood during its paſſage through the lungs. Suppoſe the thorax quite empty, and communicating with the external air by means of the trachea or windpipe, it would then reſemble a pair of bellows. Raiſing the boards correſponds to the raiſing of the ribs; and we might imitate the action of the diaphragm by forcibly pulling outwards the folded leather which unites them. Thus their capacity is enlarged, and the air ruſhes in at the nozzle by its weight in the ſame manner as water would do. The thorax differs from bellows only in this reſpect, that it is filled by the lungs, which is a vaſt collection of little bladders, like the holes in a piece of fermented bread, all communicating with the trachea, and many of them with each other. When the cheſt is enlarged, the air ruſhes into them all in the ſame manner as into the ſingle cavity of an empty thorax. It cannot be ſaid with propriety that they are inflated: all that is done is the *allowing* the air to come in. At the ſame time, as their membranous covering muſt have ſome thickneſs, however ſmall, and ſome elaſticity, it is not unlikely that, when compreſſed by expiration, they tend a little to recover their former ſhape, and thus aid the voluntary action of the muſcles. It is in this manner that a ſmall bladder of caoutchouc ſwells again after compreſſion, and fills itſelf with air or water. But this cannot happen except in the moſt minute veſicles: thoſe of ſenſible bulk have not elaſticity enough for this purpoſe. The lungs of birds, however, have ſome very large bladders, which have a very conſiderable elaſticity, and recover their ſhape and ſize with great force after compreſſion, and thus fill themſelves with air. The reſpiration of theſe animals is conſiderably different from that of land animals, and their muſcles act chiefly in expiration. This will be explained by and by as a curious variety in the pneumatic inſtrument.

This account of the manner in which the lungs are filled

Effects of Air's pressure.

filled with air does not seem agreeable to the notions we entertain of it. We seem to suck in the air; but although it be true that we act, and exert force, in order

349 We take in air not by our own action, but by external pressure.

to get air into our lungs, it is not by our action, but by external pressure, that it does come in. If we apply our mouth to the top of a bottle filled with water, we find that no draught, as we call it, of our chest will suck in any of the water; but if we suck in the very same manner at the end of a pipe immersed in water, it follows immediately. Our interest in the thing makes us connect in imagination our own action with the effect, without thinking on the many steps which may intervene in the train of natural operations; and we consider the action as the immediate cause of the air's reception into the lungs. It is as if we opened the door, and took in by the hand a person who was really pushed in by the crowd without. If an incision be made into the side of the thorax, so that the air can get in by that way, when the animal acts in the usual manner, the air will really come in by this hole, and fill the space between the lungs and thorax; but no air is sucked into the lungs by this process, and the animal is as completely suffocated as if the windpipe were shut up. And, on the other hand, if a hole be made into the lungs without communicating with the thorax, the animal will breathe through this hole, though the windpipe be stopped. This is successfully performed in cases of patients whose trachea is shut up by accident or by inflammation; only it is necessary that this perforation be made into a part of the lungs where it may meet with some of the great pulmonary passages; for if made into some remote part of a lobe, the air cannot find its way into the rest of the lungs through such narrow passages, obstructed too by blood, &c.

350 Nature of expiration.

We have now explained, on pneumatical principles, the process of inspiration. The expiration is chiefly performed by the natural tone of the parts. In the act of inspiration the ribs were raised and drawn outwards in opposition to the elasticity of the solids themselves; for although the ribs are articulated at their extremities, the articulations are by no means such as to give a free and easy motion like the joints of the limbs. This is particularly the case in the articulations with the sternum, which are by no means fitted for motion. It would seem that the motion really produced here is chiefly by the yielding of the cartilaginous parts and the bending of the rib; when therefore the muscles which produced this effect are allowed to relax, the ribs again collapse. Perhaps this is assisted a little by the action of the long muscles which come down across the ribs without being inserted into them. These may draw them together a little, as we compress a loose bundle by a string.

In like manner, when the diaphragm was drawn down, it compressed the abdomen in opposition to the elasticity of all the viscera contained in it, and to the elasticity and tone of the teguments and muscles which surround it. When therefore the diaphragm is relaxed, these parts push it up again into its natural situation, and in doing this expel the air from the lungs.

351 It requires no effort.

If this be a just account of the matter, expiration should be performed without any effort. This accordingly is the case. We feel that, after having made an ordinary easy inspiration, it requires the continuance of the effort to keep the thorax in this enlarged state, and that all that is necessary for expiration is to cease to act. No person feels any difficulty in emptying the lungs; but weak people often feel a difficulty of inspiration, and compare it to the feeling of a weight on their breast; and expiration is the last motion of the thorax in a dying person.

But nature has also given us a mechanism by which we can expire, namely, the abdominal muscles; and when we have finished an ordinary and easy expiration, we can still expel a considerable bulk of air (nearly half of the contents of the lungs) by contracting the abdominal muscles. These, by compressing the body, force up its moveable contents against the diaphragm, and cause it to rise further into the thorax, acting in the same manner as when we expel the fæces *per anum*. When a person breathes out as much air as he can in this manner, he may observe that his ribs do not collapse during the whole operation.

There seems then to be a certain natural unconstrained state of the vesicles of the lungs, and a certain quantity of air necessary for keeping them of this size. It is probable that this state of the lungs gives the freest motion to the blood. Were they more compressed, the blood vessels would be compressed by the adjoining vesicles; were they more lax, the vessels would be more crooked, and by this means obstructed. The frequent inspirations gradually change this air by mixing fresh air with it, and at every expiration carrying off some of it. In catarrhs and inflammations, especially when attended with suppuration, the small passages into the remote vessels are obstructed, and thus the renewal of air in them will be prevented. The painful feeling which this occasions causes us to expel the air with violence, shutting the windpipe, till we have exerted strongly with the abdominal muscles, and made a strong compression on the lower part of the thorax. We then open the passage suddenly, and expel the air and obstructing matter by violent coughing.

We have said, that birds exhibit a curious variety in the process of breathing. The muscles of their wings being so very great, required a very extensive insertion, and this is one use of the great breast-bone. Another use of it is, to form a firm partition to hinder the action of these muscles from compressing the thorax in the act of flying: therefore the form of their chest does not admit of alternate enlargement and contraction to that degree as in land animals. Moreover, the muscles of their abdomen are also very small; and it would seem that they are not sufficient for producing the compression on the bowels which is necessary for carrying on the process of concoction and digestion. Instead of aiding the lungs, they receive help from them.

In an ostrich, the lungs consist of a fleshy part A, A (fig. 61.), composed of vesicles like those of land animals, and, like theirs, serving to expose the blood to the action of the air. Besides these, they have on each side four large bags B, C, D, E, each of which has an orifice G communicating with the trachea; but the second, C, has also an orifice H, by which it communicates with another bag F situated below the rest in the abdomen. Now, when the lungs are compressed by the action of the diaphragm, the air in C is partly expelled by the trachea through the orifice G, and partly driven through the orifice H into the bag F, which

which is then allowed to receive it; becauſe the ſame action which compreſſes the lungs enlarges the abdomen. When the thorax is enlarged, the bag C is partly ſupplied with freſh air through the trachea, and partly from the bag F. As the lungs of other animals reſemble a common bellows, the lungs of birds reſemble the ſmith's bellows with a partition; and anatomiſts have diſcovered paſſages from this part of the lungs into their hollow bones and quills. We do not know all the uſes of this contrivance; and only can obſerve, that this alternate action muſt aſſiſt the muſcles of the abdomen in promoting the motion of the food along the alimentary canal, &c. We can diſtinctly obſerve in birds that their belly dilates when the cheſt collapſes, and *vice verſa*, contrary to what we ſee in the land animals. Another uſe of this double paſſage may be to produce a circulation of air in the lungs, by which a compenſation is made for the ſmaller ſurface of action on the blood: for the number of ſmall veſicles, of equal capacity with theſe large bags, gives a much more extenſive ſurface.

If we try to raiſe mercury in a pipe by the action of the cheſt alone, we cannot raiſe it above two or three inches; and the attempt is both painful and hazardous. It is painful chiefly in the breaſt, and it provokes coughing. Probably the fluids ooze through the pores of the veſicles by the preſſure of the ſurrounding parts.

On the other hand, we can by expiration ſupport mercury about five or ſix inches high: but this alſo is very painful, and apt to produce extravaſation of blood. This ſeems to be done entirely by the abdominal muſcles.

The operation properly termed SUCKING is totally different from breathing, and reſembles exceedingly the action of a common pump. Suppoſe a pipe held in the mouth, and its lower end immerſed in water. We fill the mouth with the tongue, bringing it forward, and applying it cloſely to the teeth and to the palate; we then draw it back, or bend it downwards (behind) from the palate, thus leaving a void. The preſſure of the air on the cheeks immediately depreſſes them, and applies them cloſe to the gums and teeth; and its preſſure on the water in the veſſel cauſes it to riſe through the pipe into the empty part of the mouth, which it quickly fills. We then puſh forward the tip of the tongue, below the water, to the teeth, and apply it to them all round, the water being above the tongue, which is kept much depreſſed. We then apply the tongue to the palate, beginning at the tip, and gradually going backward in this application. By this means the water is gradually forced backward by an operation ſimilar to that of the gullet in ſwallowing. This is done by contracting the gullet above and relaxing it below, juſt as we would empty a gut of its contents by drawing our cloſed hand along it. By this operation the mouth is again completely occupied by the tongue, and we are ready for repeating the operation. Thus the mouth and tongue reſemble the barrel and piſton of a pump; and the application of the tip of the tongue to the teeth performs the office of the valve at the bottom of the barrel, preventing the return of the water into the pipe. Although uſual, it is not abſolutely neceſſary, to withdraw the tip of the tongue, making a void before the tongue. Sucking may be performed by merely ſeparating the tongue gradually from the palate, beginning at the root. If we withdraw the tip of the tongue a very minute quantity, the water gets in and flows back above the tongue.

Effects of Air's preſſure.

The action of the tongue in this operation is very powerful; ſome perſons can raiſe mercury 25 inches: but this ſtrong exertion is very fatiguing, and the ſoft parts are prodigiouſly ſwelled by it. It cauſes the blood to ooze plentifully through the pores of the tongue, fauces, and palate, in the ſame manner as if a cupping-glaſs and ſyringe were applied to them; and, when the inſide of the mouth is excoriated or tender, as is frequent with infants, even a very moderate exertion of this kind is accompanied with extravaſation of blood. When children ſuck the nurſes breaſt, the milk follows their exertion by the preſſure of the air on the breaſt; and a weak child, or one that withholds its exertions on account of pain from the above-mentioned cauſe, may be aſſiſted by a gentle preſſure of the hand on the breaſt: the infant pupil of nature, without any knowledge of pneumatics, frequently helps itſelf by preſſing its face to the yielding breaſt.

In the whole of this operation the breathing is performed through the noſtrils; and it is a prodigious diſtreſs to an infant when this paſſage is obſtructed by mucus. We beg to be forgiven for obſerving by the way, that this obſtruction may be almoſt certainly removed for a little while, by rubbing the child's noſe with any liquid of quick evaporation, or even with water.

355 And of drinking, which is very ſimilar.

The operation in drinking is not very different from that in ſucking: we have indeed little occaſion here to ſuck, but we muſt do it a little. Dogs and ſome other animals cannot drink, but only lap the water into their mouths with their tongue, and then ſwallow it. The gallinaceous birds ſeem to drink very imperfectly; they ſeem merely to dip their head into the water up to the eyes till their mouth is filled with water, and then holding up the head, it gets into the gullet by its weight, and is then ſwallowed. The elephant drinks in a very complicated manner; he dips his trunk into the water, and fills it by making a void in his mouth: this he does in the contrary way to man. After having depreſſed his tongue, he begins the application of it to the palate at the root, and by extending the application forward, he expels the air by the mouth which came into it from the trunk. The proceſs here is not very unlike that of the condenſing ſyringe without a piſton valve, deſcribed in n° 58, in which the external air (correſponding here to the air in the trunk) enters by the hole F in the ſide, and is expelled through the hole in the end of the barrel; by this operation the trunk is filled with water: then he lifts his trunk out of the water, and bringing it to his mouth, pours the contents into it, and ſwallows it. On conſidering this operation, it appears that, by the ſame proceſs by which the air of the trunk is taken into the mouth, the water could alſo be taken in, to be afterwards ſwallowed: but we do not find, upon inquiry, that this is done by the elephant; we have always obſerved him to drink in the manner now deſcribed. In either way it is a double operation, and cannot be carried on any way but by alternately ſucking and ſwallowing, and while one operation is going on the other is interrupted; whereas man can do both at the ſame time. Nature ſeems to delight in exhibiting to rational obſervers her inexhauſtible variety of reſource; for many inſects, which drink with a trunk, drink without interruption: yet we

Effects of Air's preſſure.

do not call in queſtion the truth of the aphoriſm, *Natura maxime ſimplex et ſemper ſibi conſona*, nor doubt but that, if the *whole* of her purpoſe were ſeen, we ſhould find that her proceſs is the ſimpleſt poſſible: for Nature, or Nature's God, is wiſe above our wiſeſt thoughts, and ſimplicity is certainly the choice of wiſdom: but alas! it is generally but a ſmall and the moſt obvious part of her purpoſe that we can obſerve or appreciate. We ſeldom ſee this ſimplicity of nature ſtated to us, except by ſome ſyſtem-maker, who has found a principle which ſomehow tallies with a conſiderable variety of phenomena, and then cries out, *Fruſtra fit per plura quod fieri poteſt per pauciora.*

356 Mode of keeping up a continued blaſt with a blow-pipe.

There is an operation ſimilar to that of the elephant, which many find a great difficulty in acquiring, viz. keeping up a continued blaſt with a blow-pipe. We would deſire our chemical reader to attend minutely to the gradual action of his tongue in ſucking, and he will find it ſuch as we have deſcribed. Let him attend particularly to the way in which the tip of the tongue performs the office of a valve, preventing the return of the water into the pipe: the ſame poſition of the tongue would hinder air from coming into the mouth. Next let him obſerve, that in ſwallowing what water he has now got lodged above his tongue, he continues the tip of the tongue applied to the teeth; now let him ſhut his mouth, keeping his lips firm together, the tip of the tongue at the teeth, and the whole tongue forcibly kept at a diſtance from the palate; bring up the tongue to the palate, and allow the tip to ſeparate a little from the teeth; this will expel the air into the ſpace between the fauces and cheeks, and will blow up the cheeks a little: then, acting with the tip of the tongue as a valve, hinder this air from getting back, and depreſſing the tongue again, more air (from the noſtrils) will get into the mouth, which may be expelled into the ſpace without the teeth as before, and the cheeks will be more inflated: continue this operation, and the lips will no longer be able to retain it, and it will ooze through as long as the operation is continued. When this has become familiar and eaſy, take the blow-pipe, and there will be no difficulty in maintaining a blaſt as uniform as a ſmith's bellows, breathing all the while through the noſtrils. The only difficulty is the holding the pipe: this fatigues the lips; but it may be removed by giving the pipe a convenient ſhape, a pretty flat oval, and wrapping it round with leather or thread.

Another phenomenon depending on the principles already eſtabliſhed, is the land and ſea-breeze in the warm countries.

357 Nature of the land and ſea breeze in warm countries.

We have ſeen that air expands exceedingly by heat; therefore heated air, being lighter than an equal bulk of cold air, muſt riſe in it. If we lay a hot ſtone in the ſunſhine in a room, we ſhall obſerve the ſhadow of the ſtone ſurrounded with a fluttering ſhadow of different degrees of brightneſs, and that this flutter riſes rapidly in a column above the ſtone. If we hold an extinguiſhed candle near the ſtone, we ſhall ſee the ſmoke move towards the ſtone, and then aſcend up from it. Now, ſuppoſe an iſland receiving the firſt rays of the ſun in a perfectly calm morning; the ground will ſoon be warmed, and will warm the contiguous air. If the iſland be mountainous, this effect will be more remarkable; becauſe the inclined ſides of the hills will receive the light more directly: the midland air will therefore be moſt warmed: the heated air will riſe, and that in the middle will riſe faſteſt; and thus a current of air upwards will begin, which muſt be ſupplied by air coming in from all ſides, to be heated and to riſe in its turn; and thus the morning *ſea-breeze* is produced, and continues all day. This current will frequently be reverſed during the night, by the air cooling and gliding down the ſides of the hills, and we ſhall have the *land-breeze*.

358 Circulation of air in mines.

It is owing to the ſame cauſe that we have a circulation of air in mines which have the mouths of their ſhafts of unequal heights. The temperature underground is pretty conſtant through the whole year, while that of the atmoſphere is extremely variable. Now, ſuppoſe a mine having a long horizontal drift, communicating between two pits or ſhafts, and that one of theſe ſhafts terminates in a valley, while the other opens on the brow of a hill perhaps 100 feet higher. Let us further ſuppoſe it ſummer, and the air heated to 65°, while the temperature of the earth is but 45°; this laſt will be alſo the temperature of the air in the ſhafts and the drift. Now, ſince air expands nearly 24 parts in 10000 by one degree of heat, we ſhall have an odds of preſſure at the bottom of the two ſhafts equal to nearly the 20th part of the weight of a column of air 100 feet high (100 feet being ſuppoſed the difference of the heights of the ſhafts). This will be about ſix ounces on every ſquare foot of the ſection of the ſhaft. If this preſſure could be continued, it would produce a prodigious current of air down the long ſhaft, along the drift, and up the ſhort ſhaft. The weight of the air acting through 100 feet would communicate to it the velocity of 80 feet *per* ſecond: divide this by $\sqrt{20}$, that is, by 4,5, and we ſhall have 18 feet *per* ſecond for the velocity: this is the velocity of what is called a briſk gale. This preſſure *would* be continued, if the warm air which enters the long ſhaft were cooled and condenſed as faſt as it comes in; but this is not the caſe. *It is however cooled* and condenſed, and a current is produced ſufficient to make an abundant circulation of air along the whole paſſage; and care is taken to diſpoſe the ſhafts and conduct the paſſages in ſuch a manner that no part of the mine is out of the circle. When any new lateral drift is made, the renewal of air at its extremity becomes more imperfect as it advances; and when it is carried a certain length, the air ſtagnates and becomes ſuffocating, till either a communication can be made with the reſt of the mine, or a ſhaft be made at the end of this drift.

As this current depends entirely on the difference of temperature between the air below and that above, it muſt ceaſe when this difference ceaſes. Accordingly, in the ſpring and autumn, the miners complain much of ſtagnation; but in ſummer they never want a current from the deep pits to the ſhallow, nor in the winter a current from the ſhallow pits to the deep ones. It frequently happens alſo, that in mineral countries the chemical changes which are going on in different parts of the earth make differences of temperature ſufficient to produce a ſenſible current.

It is eaſy to ſee that the ſame cauſes muſt produce a current down our chimneys in ſummer. The chimney is colder than the ſummer air, and muſt therefore condenſe it, and it will come down and run out at the doors and windows.

359 The na[ture] of wha[t is] called draugh[t] by chimne[ys].

And this naturally leads us to conſider a very important effect of the expanſion and conſequent aſcent of air by chimneys.

Effects of Air's pressure.

by heat, namely the drawing (as it is called) of chimneys. The air which has contributed to the burning of fuel muſt be intenſely heated, and will riſe in the atmoſphere. This will alſo be the caſe with much of the ſurrounding air which has come very near the fire, although not in contact with it. If this heated air be made to riſe in a pipe, it will be kept together, and therefore will not ſoon cool and collapſe; thus we ſhall obtain a long column of light air, which will riſe with a force ſo much the greater as the column is longer or more heated. Therefore the taller we make the chimney, or the hotter we make the fire, the more rapid will be the current, or the draught or ſuction, as it is injudiciouſly called, will be ſo much the greater. The aſcenſional force is the difference between the weight of the column of heated air in the funnel and a column of the ſurrounding atmoſphere of equal height. We increaſe the draught, therefore, by increaſing the perpendicular height of the chimney. Its length in a horizontal direction gives no increaſe, but, on the contrary, diminiſhes the draught by cooling the air before it gets into the effective part of the funnel. We increaſe the draught alſo by obliging all the air which enters the chimney to come very near the fuel; therefore a low mantle-piece will produce this effect; alſo filling up all the ſpaces on each ſide of the grate. When much air gets in above the fire, by having a lofty mantle-piece, the general maſs of air in the chimney cannot be much heated. Hence it muſt happen that the greateſt draught will be produced by bringing down the mantle-piece to the very fuel; but this converts a fire-place into a furnace, and by thus ſending the whole air through the fuel, cauſes it to burn with great rapidity, producing a prodigious heat; and this producing an increaſe of aſcenſional force, the current becomes furiouſly rapid, and the heat and conſumption of fuel immenſe. If the fire-place be a cube of a foot and a half, and the front cloſed by a door, ſo that all the air muſt enter through the bottom of the grate, a chimney of 15 or 20 feet high, and ſufficiently wide to give paſſage to all the expanded air which can paſs through the fire, will produce a current which will roar like thunder, and a heat ſufficient to run the whole inſide into a lump of glaſs.

All that is neceſſary, however, in a chamber fire-place, is a current ſufficiently great for carrying up the ſmoke and vitiated air of the fuel. And as we want alſo the enlivening flutter and light of the fire, we give the chimney-piece both a much greater height and width than what is merely neceſſary for carrying up the ſmoke, only wiſhing to have the current ſufficiently determinate and ſteady for counteracting any occaſional tendency which it may ſometimes have to come into the room. By allowing a greater quantity of air to get into the chimney, heated only to a moderate degree, we produce a more rapid renewal of the air of the room: did we oblige it to come ſo much nearer the fire as to produce the ſame renewal of the air in conſequence of a more rapid current, we ſhould produce an inconvenient heat. But in this country, where pit-coal is in general ſo very cheap, we carry this indulgence to an extreme; or rather we have not ſtudied how to get all the deſired advantages with economy. A much ſmaller renewal of air than we commonly produce is abundantly wholeſome and pleaſant, and we may have all the pleaſure of the light and flame of the fuel at much leſs expence, by contracting greatly the paſſage into the vent. The beſt way of doing this is by contracting the brick-work on each ſide behind the mantle-piece, and reducing it to a narrow parallelogram, having the back of the vent for one of its long ſides. Make an iron plate to fit this hole, of the ſame length, but broader, ſo that it may lie ſloping, its lower edge being in contact with the foreſide of the hole, and its upper edge leaning on the back of the vent. In this poſition it ſhuts the hole entirely. Now let the plate have a hinge along the front or lower edge, and fold up like the lid of a cheſt. We ſhall thus be able to enlarge the paſſage at pleaſure. In a fire-place fit for a room of 24 feet by 18, if this plate may be about 18 inches long from ſide to ſide, and folded back within an inch or an inch and a half of the wall, this will allow paſſage for as much air as will keep up a very cheerful fire; and by raiſing or lowering this Register, the fire may be made to burn more or leſs rapidly. A free paſſage of half an inch will be ſufficient in weather that is not immoderately cold. The principle on which this conſtruction produces its effect is, that the air which is in the front of the fire, and much warmed by it, is not allowed to get into the chimney, where it would be immediately hurried up the vent, but riſes up to the ceiling and is diffuſed over the whole room. This double motion of the air may be diſtinctly obſerved by opening a little of the door and holding a candle in the way. If the candle be held near the floor, the flame will be blown into the room; but if held near the top of the door, the flame will be blown outward.

360 Deſcription of a ſtove-grate or chapelle.

But the moſt perfect method of warming an apartment in theſe temperate climates, where we can indulge in the cheerfulneſs and ſweet air produced by an open fire, is what we call a ſtove-grate, and our neighbours on the continent call a chapelle, from its reſemblance to the chapels or oratories in the great churches.

In the great chimney-piece, which, in this caſe, may be made even larger than ordinary, is ſet a ſmaller one fitted up in the ſame ſtile of ornament, but of a ſize no greater than is ſufficient for holding the fuel. The ſides and back of it are made of iron (caſt iron is preferable to hammered iron, becauſe it does not ſo readily calcine), and are kept at a ſmall diſtance from the ſides and back of the main chimney-piece, and are continued down to the hearth, ſo that the aſh-pit is alſo ſeparated. The pipe or chimney of the ſtove grate is carried up behind the ornaments of the mantle-piece till it riſes above the mantle-piece of the main chimney-piece, and is fitted with a regiſter or damper-plate turning round a tranſverſe axis. The beſt form of this regiſter is that which we have recommended for an ordinary fire-place, having its axis or joint cloſe at the front; ſo that when it is open or turned up, the burnt air and ſmoke ſtriking it obliquely, are directed with certainty into the vent, without any riſk of reverberating and coming out into the room. All the reſt of the vent is ſhut up by iron plates or brick-work out of ſight.

361 Effect of its conſtruction.

The effect of this conſtruction is very obvious. The fuel, being in immediate contact with the back and ſides of the grate, heat them to a great degree, and they heat the air contiguous to them. This heated

air

Effects of Air's pressure.

air cannot get up the vent, because the passages above these spaces are shut up. It therefore comes out into the room; some of it goes into the real fire-place and is carried up the vent, and the rest rises to the ceiling and is diffused over the room.

It is surprising to a person who does not consider it with skill how powerfully this grate warms a room. Less than one-fourth of the fuel consumed in an ordinary fire-place is sufficient; and this with the same cheerful blazing hearth and salutary renewal of air. It even requires attention to keep the room cool enough. The heat communicated to those parts in contact with the fuel is needlessly great; and it will be a considerable improvement to line this part with very thick plates of cast iron, or with tiles made of fire-clay which will not crack with the heat. These, being very bad conductors, will make the heat, ultimately communicated to the air, very moderate. If, with all these precautions, the heat should be found too great, it may be brought under perfect management by opening passages into the vent from the lateral spaces. These may be valves or trap-doors moved by rods concealed behind the ornaments.

Thus we have a fire-place under the most complete regulation, where we can always have a cheerful fire without being for a quarter of an hour incommoded by the heat; and we can as quickly raise our fire, when too low, by hanging on a plate of iron on the front, which shall reach as low as the grate. This in five minutes will blow up the fire into a glow; and the plate may be sent out of the room, or set behind the stove-grate out of sight.

The propriety of inclosing the ash-pit is not so obvious; but if this be not done, the light ashes, not finding a ready passage up the chimney, will come out into the room along with the heated air.

We do not consider in this place the various extraneous circumstances which impede the current of air in our chimneys and produce smoky houses: these will be treated of, and the methods of removing or remedying them, under the article SMOKE. We consider at present only the theory of this motion in general, and the modifications of its operation arising from the various purposes to which it may be applied.

362 Mode of warming apartments by stoves.

Under this head we shall next give a general account and description of the method of warming apartments by stoves. A STOVE in general is a fire-place shut up on all sides, having only a passage for admitting the air to support the fire, and a tube for carrying off the vitiated air and smoke; and the air of the room is warmed by coming into contact with the outside of the stove and flue. The general principle of construction, therefore, is very simple. The air must be made to come into as close contact as possible with the fire, or even to pass through it, and this in such quantities as just to consume a quantity of fuel sufficient for producing the heat required; and the stove must be so constructed, that both the burning fuel and the air which has been heated by it shall be applied to as extensive a surface as possible of furnace, all in contact with the air of the room; and the heated air within the stove must not be allowed to get into the funnel which is to carry it off till it is too much cooled to produce any considerable heat on the outside of the stove.

In this temperate climate no great ingenuity is necessary for warming an ordinary apartment; and stoves are made rather to please the eye as furniture than as economical substitutes for an open fire of equal calorific power. But our neighbours on the continent, and especially towards the north, where the cold of winter is intense and fuel very dear, have bestowed much attention on their construction, and have combined ingenious economy with every elegance of form. Nothing can be handsomer than the stoves of Fayencerie that are to be seen in French Flanders, or the Russian stoves at St Petersburgh, finished in stucco. Our readers will not, therefore, be displeased with a description of them. In this place, however, we shall only consider a stove in general as a subject of pneumatical discussion, and we refer our readers to the article STOVE for an account of them as articles of domestic accommodation.

The general form, therefore, of a stove, and of which all others are only modifications adapted to circumstances of utility or taste, is as follows: 363 General form of a stove.

MIKL (fig. 62.) is a quadrangular box of any size in the directions MI IK. The inside width from front to back is pretty constant, never less than ten inches, and rarely extending to 20; the included space is divided by a great many partitions. The lowest chamber AB is the receptacle for the fuel, which lies on the bottom of the stove without any grate: this fire-place has a door AO turning on hinges, and in this door is a very small wicket P: the roof of the fire-place extends to within a very few inches of the farther end, leaving a narrow passage B for the flame. The next partition *c* C is about eight inches higher, and reaches almost to the other end, leaving a narrow passage for the flame at C. The partitions are repeated above, at the distance of eight inches, leaving passages at the ends, alternately disposed as in the figure; the last of them H communicates with the room vent. This communication may be regulated by a plate of iron, which can be slid across it by means of a rod or handle which comes through the side. The more usual way of shutting up this passage is by a sort of pan or bowl of earthen ware, which is whelmed over it with its brim resting in sand contained in a groove formed all round the hole. This damper is introduced by a door in the front, which is then shut. The whole is set on low pillars, so that its bottom may be a few inches from the floor of the room: it is usually placed in a corner, and the apartments are so disposed that their chimneys can be joined in stacks as with us. Plate CCCCV.

Some straw or wood-shavings are first burnt on the hearth at its farther end. This warms the air in the stove, and creates a determined current. The fuel is then laid on the hearth close by the door, and pretty much piled up. It is now kindled; and the current being already directed to the vent, there is no danger of any smoke coming out into the room. Effectually to prevent this, the door is shut, and the wicket P opened. The air supplied by this, being directed to the middle or bottom of the fuel, quickly kindles it, and the operation goes on.

364 Aim and effects of this construction.

The aim of this construction is very obvious. The flame and heated air are retained as long as possible within the body of the stove by means of the long passages; and the narrowness of these passages obliges the flame to come in contact with every particle of soot, so as to consume it completely, and thus convert the whole combustible

Effects of Air's pressure.

combustible matter of the fuel into heat. For want of this a very considerable portion of our fuel is wasted by our open fires, even under the very best management: the soot which sticks to our vents is very inflammable, and a pound weight of it will give as much if not more heat than a pound of coal. And what sticks to our vents is very inconsiderable in comparison with what escapes unconsumed at the chimney top. In fires of green wood, peat, and some kinds of pit-coal, nearly $\frac{1}{7}$ of the fuel is lost in this way; but in these stoves there is hardly ever any mark of soot to be seen; and even this small quantity is produced only after lighting the fires. The volatile inflammable matters are expelled from parts much heated indeed, but not so hot as to burn; and some of it charred or half-burnt cannot be any further consumed, being enveloped in flame and air already vitiated and unfit for combustion. But when the stove is well heated, and the current brisk, no part of the soot escapes the action of the air.

The hot air retained in this manner in the body of the stove is applied to its sides in a very extended surface. To increase this still more, the stove is made narrower from front to back in its upper part; a certain breadth is necessary below, that there may be room for fuel. If this breadth were preserved all the way up, much heat would be lost, because the heat communicated to the partitions of the stove does no good. By diminishing their breadth, the proportion of useful surface is increased. The whole body of the stove may be considered as a long pipe folded up, and its effect would be the greatest possible if it really were so; that is, if each partition *c*C, *d*D, &c. were split into two, and a free passage allowed between them for the air of the room. Something like this will be observed afterwards in some German stoves.

It is with the same view of making an extensive application of a hot surface to the air, that the stove is not built in the wall, nor even in contact with it, nor with the floor: for by its detached situation, the air in contact with the back, and with the bottom (where it is hottest), is warmed, and contributes at least one half of the whole effect; for the great heat of the bottom makes its effect on the air of the room at least equal to that of the two ends. Sometimes a stove makes part of the wall between two small rooms, and is found sufficient.

It must be remarked, on the whole, that the effect of a stove depends much on keeping in the room the air already heated by it. This is so remarkably the case, that a small open fire in the same room will be so far from increasing its heat, that it will greatly diminish it: it will even draw the warm air from a suite of adjoining apartments. This is distinctly observed in the houses of the English merchants in St Petersburgh: their habits of life in Britain make them uneasy without an open fire in their sitting rooms; and this obliges them to heat all their stoves twice a day, and their houses are cooler than those of the Russians who heat them only once. In many German houses, especially of the lower class, the fire-place of the stove does not open into the room, but into the yard or a lobby, where all the fires are lighted and tended; by this means is avoided the expence of warm air which must have been carried off by the stove: but it is evident, that this must be very unpleasant, and cannot be wholesome. We must breathe the same quantity of stagnant air loaded with all the vapours and exhalations which must be produced in every inhabited place. Going into one of these houses from the open air, is like putting one's head into a stew-pan or under a pie-crust, and quickly nauseates us who are accustomed to fresh air and cleanliness. In these countries it is a matter almost of necessity, to fumigate the rooms with frankincense and other gums burnt. The censer in ancient worship was in all probability an utensil introduced by necessity for sweetening or rendering tolerable the air of a crouded place: and it is a constant practice in the Russian houses for a servant to go round the room after dinner, waving a censer with some gums burning on bits of charcoal.

365 Of hot walls in gardening, &c.

The account now given of stoves for heating rooms, and of the circumstances which must be attended to in their construction, will equally apply to hot walls in gardening, whether within or without doors. The only new circumstance which this employment of a flue introduces, is the attention which must be paid to the equability of the heat, and the gradation which must be observed in different parts of the building. The heat in the flue gradually diminishes as it recedes from the fire-place, because it is continually giving out heat to the flue. It must therefore be so conducted through the building by frequent returns, that in every part there may be a mixture of warmer and cooler branches of the flue, and the final chimney should be close by the fire-place. It would, however, be improper to run the flue from the end of the floor up to the ceiling, where the second horizontal pipe would be placed, and then return it downward again and make the third horizontal flue adjoining to the first, &c. This would make the middle of the wall the coldest. If it is the flue of a greenhouse, this would be highly improper, because the upper part of the wall can be very little employed; and in this case it is better to allow the flue to proceed gradually up the wall in its different returns, by which the lowest part would be the warmest, and the heated air will ascend among the pots and plants; but in a hot wall, where the trees are to receive heat by contact, some approximation to the above method may be useful.

In the hypocausta and sudaria of the Greeks and Romans, the flue was conducted chiefly under the floors.

366 Malt-kilns a species of stove.

Malt-kilns are a species of stove which merit our attention. Many attempts have been made to improve them on the principal of flue stoves; but they have been unsuccessful, because heat is not what is chiefly wanted in malting: it is a copious current of very dry air to carry off the moisture. We must refer the examination of this subject also to the article STOVE, and proceed to consider the current of heated air in the chief varieties of furnaces.

367 Of the current of air in melting furnaces.

All that is to be attended to in the different kinds of melting furnaces is, that the current of air be sufficiently rapid, and that it be applied in as extensive a surface as possible to the substance to be melted. The more rapid the current it is the hotter, because it is consuming more fuel; and therefore its effect increases in a higher proportion than its rapidity. It is doubly effectual if twice as hot; and if it then be twice as rapid, there is twice the quantity of doubly hot air applied to the subject; it would therefore be four times more powerful. This is procured by raising the chimney of the furnace to a greater height. The close application of it to the subject can hardly be laid down in general terms, be-

Effects of Air's pressure.

cause it depends on the precise circumstances of each case.

368 In reverberatory furnaces,

In reverberatory furnaces, such as refining furnaces for gold, silver, and copper, the flame is made to play over the surface of the melted metal. This is produced entirely by the form of the furnace, by making the arch of the furnace as low as the circumstances of the manipulation will allow (See FURNACE, p. 509.). Experience has pointed out in general the chief circumstances of their construction, viz, that the fuel should be at one end on a grate, through which the air enters to maintain the fire; and that the metal should be placed on a level floor between the fuel and the tall chimney which produces the current. But there is no kind of furnace more variable in its effect, and almost every place has a small peculiarity of construction, on which its pre-eminence is rested. This has occasioned many whimsical varieties in their form. This uncertainty seems to depend much on a circumstance rather foreign to our present purpose; but as we do not observe it taken notice of by mineralogical writers, we beg leave to mention it here. It is not heat alone that is wanted in the refining of silver by lead, for instance. We must make a continual application to its surface of air, which has not contributed to the combustion of the fuel. Any quantity of the hottest air, already saturated with the fuel, may play on the surface of the metal for ever, and keep it in the state of most perfect fusion, but without refining it in the least. Now, in the ordinary construction of a furnace, this is much the case. If the whole air has come in by the grate, and passed through the middle of the fuel, it can hardly be otherwise than nearly saturated with it; and if air be also admitted by the door (which is generally done or something equivalent), the pure air lies above the vitiated air, and during the passage along the horizontal part of the furnace, and along the surface of the metal, it still keeps above it, at least there is nothing to promote their mixture. Thus the metal does not come into contact with air fit to act on the base metal and calcine it, and the operation of refining goes on slowly. Trifling circumstances in the form of the arch or canal may tend to promote the jumbling of the airs together, and thus render the operation more expeditious; and as these are but ill understood, or perhaps this circumstance not attended to, no wonder that we see these considered as so many nostrums of great importance. It were therefore worth while to try the effect of changes in the form of the roof directed to this very circumstance. Perhaps some little prominence down from the arch of the reverberatory would have this effect, by suddenly throwing the current into confusion. If the additional length of passage do not cool the air too much, we should think that if there were interposed between the fuel and the refining floor a passage twisted like a cork-screw, making just half a turn, it would be most effectual: for we imagine, that the two airs, keeping each to their respective sides of the passage, would by this means be turned upside down, and that the pure stratum would now be in contact with the metal, and the vitiated air would be above it.

369 And in the glass-house furnaces.

The glasshouse furnace exhibits the chief variety in the management of the current of heated air. In this it is necessary that the hole at which the workman dips his pipe into the pot shall be as hot as any part of the furnace. This could never be the case, if the furnace had a chimney situated in a part above the dipping-hole; for in this case cold air would immediately rush in at the hole, play over the surface of the pot, and go up the chimney. To prevent this the hole itself is made the chimney; but as this would be too short, and would produce very little current and very little heat, the whole furnace is set under a tall dome. Thus the heated air from the real furnace is confined in this dome, and constitutes a high column of very light air, which will therefore rise with great force up the dome, and escape at the top. The dome is therefore the chimney, and will produce a draught or current proportioned to its height. Some are raised above an hundred feet. When all the doors of this house are shut, and thus no supply given except through the fire, the current and heat become prodigious. This, however, cannot be done, because the workmen are in this chimney, and must have respirable air. But notwithstanding this supply by the house-doors, the draught of the real furnace is vastly increased by the dome, and a heat produced sufficient for the work, and which could not have been produced without the dome.

370 Improvement of Mr Cotterel for melting iron from the ore.

This has been applied with great ingenuity and effect to a furnace for melting iron from the ore, and an iron finery, both without a blast. The common blast iron furnace is well known. It is a tall cone with the apex undermost. The ore and fluxes are thrown into this cone mixed intimately with the fuel till it is full, and the blast of most powerful bellows is directed into the bottom of this cone through a hole in the side. The air is thrown in with such force, that it makes its way through the mass of matter, kindles the fuel in its passage, and fluxes the materials, which then drop down into a receptacle below the blast-hole, and thus the passage for the air is kept unobstructed. It was thought impossible to produce or maintain this current without bellows; but Mr Cotterel, an ingenious founder, tried the effect of a tall dome placed over the mouth of the furnace, and though it was not half the height of many glasshouse domes it had the desired effect. Considerable difficulties, however, occurred; and he had not surmounted them all when he left the neighbourhood of Edinburgh, nor have we heard that he has yet brought the invention to perfection. It is extremely difficult to place the holes below, at which the air is to enter, at such a precise height as neither to be choked by the melted matter, nor to leave ore and stones below them unmelted; but the invention is very ingenious, and will be of immense service if it can be perfected; for in many places iron ore is to be found where water cannot be had for working a blast furnace.

371 Currents of air applied to free mines, ships, prisons, &c. of noxious air.

The last application which we shall make of the currents produced by heating the air is to the freeing mines, ships, prisons, &c. from the damp and noxious vapours which frequently infest them.

As a drift or work is carried on in the mine, let a trunk of dale boards, about 6 or 8 inches square, be laid along the bottom of the drift, communicating with a trunk carried up in the corner of one of the shafts. Let the top of this last trunk open into the ash-pit of a small furnace, having a tall chimney. Let fire be kindled in the furnace; and when it is well heated, shut the fire-place and ash-pit doors. There being no other supply for the current produced in the chimney of this

 furnace,

furnace, the air will flow into it from the trunk, and will bring along with it all the offenfive vapours. This is the moft effectual method yet found out. In the fame manner may trunks be conducted into the afh-pit of a furnace from the cells of a prifon or the wards of an hofpital.

72 ...ecef- ...or the ...uftion ...l.

In the account which we have been giving of the management of air in furnaces and common fires, we have frequently mentioned the immediate application of air to the burning fuel as neceffary for its combuftion. This is a general fact. In order that any inflammable body may be really inflamed, and its combuftible matter confumed and afhes produced, it is not enough that the body be made hot. A piece of charcoal inclofed in a box of iron may be kept red-hot for ever, without wafting its fubftance in the fmalleft degree. It is farther neceffary that it be in contact with a particular fpecies of air, which conftitutes about $\frac{1}{5}$ths of the air of the atmofphere, viz. the vital air of Lavoifier. It was called *empyreal air* by Scheele, who firft obferved its indifpenfable ufe in maintaining fire: and it appears, that, in contributing to the combuftion of an inflammable body, this air combines with fome of its ingredients, and becomes fixed air, fuffering the fame change as by the breathing of animals. Combuftion may therefore be confidered as a folution of the inflammable body in air. This doctrine was firft promulgated by the celebrated Dr Hooke in his *Micrographia*, publifhed in 1660, and afterwards improved in his treatife on Lamps. It is now completely eftablifhed, and confidered as a new difcovery. It is for this reafon that in fire-places of all kinds we have directed the conftruction, fo as to produce a clofe application of the air to the fuel. It is quite needlefs at this day to enter into the difcuffions which formerly occupied philofophers about the manner in which the preffure and elafticity of the air promoted combuftion. Many experiments were made in the laft century by the firft members of the Royal Society, to difcover the office of air in combuftion. It was thought that the flame was extinguifhed in rare air for want of a preffure to keep it together; but this did not explain its extinction when the air was not renewed. Thefe experiments are ftill retained in courfes of experimental philofophy, as they are injudicioufly ftyled; but they give little or no information, nor tend to the illuftration of any pneumatical doctrine; they are therefore omitted in this place. In fhort, it is now fully eftablifhed, that it is not a mechanical but a chemical phenomenon. We can only inform the chemift, that a candle will confume fafter in the low countries than in the elevated regions of Quito and Gondar, becaufe the air is nearly one half denfer below, and will act proportionally fafter in decompofing the candle.

73 ...ous ef- ...of the ...pref-

We fhall conclude this part of our fubject with the explanation of a curious phenomenon obferved in many places. Certain fprings or fountains are obferved to have periods of repletion and fcantinefs, or feem to ebb and flow at regular intervals; and fome of thefe periods are of a complicated nature. Thus a well will have feveral returns of high and low water, the difference of which gradually increafes to a maximum, and then diminifhes, juft as we obferve in the ocean. A very ingenious and probable explanation of this has been given in N° 424. of the Philofophical Tranfactions, by Mr Atwell, as follows.

Pneumatic Engines. Plate CCCCV.

Let ABCD (fig. 63.) reprefent a cavern, into which water is brought by the fubterraneous paffage OT. Let it have an outlet MNP, of a crooked form, with its higheft part N confiderably raifed above the bottom of the cavern, and thence floping downwards into lower ground, and terminating in an open well at P. Let the dimenfions of this canal be fuch that it will difcharge much more water than is fupplied by TO. All this is very natural, and may be very common. The effect of this arrangement will be a remitting fpring at P: for when the cavern is filled higher than the point N, the canal MNP will act as a fyphon; and, by the conditions affumed, it will difcharge the water fafter than TO fupplies it; it will therefore run it dry, and then the fpring at P will ceafe to furnifh water. After fome time the cavern will again be filled up to the height N, and the flow at P will recommence.

If, befides this fupply, the well P alfo receive water from a conftant fource, we fhall have a reciprocating fpring.

The fituation and dimenfions of this fyphon canal, and the fupply of the feeder, may be fuch, that the efflux at P will be conftant. If the fupply increafe in a certain degree, a reciprocation will be produced at P with very fhort intervals; if the fupply diminifhes confiderably, we fhall have another kind of reciprocation with great intervals and great differences of water.

If the cavern has another fimple outlet R, new varieties will be produced in the fpring P, and R will afford a curious fpring. Let the mouth of R, by which the water enters it from the cavern, be lower than N, and let the fupply of the feeding fpring be no greater than R can difcharge, we fhall have a conftant fpring from R, and P will give no water. But fuppofe that the main feeder increafes in winter or in rainy feafons, but not fo much as will fupply both P and R, the cavern will fill till the water gets over N, and R will be running all the while; but foon after P has begun to flow, and the water in the cavern finks below R, the ftream from R will ftop. The cavern will be emptied by the fyphon canal MNP, and then P will ftop. The cavern will then begin to fill, and when near full R will give a little water, and foon after P will run and R ftop as before, &c.

Defaguliers fhows, Vol. II. p. 177, &c. in what manner a prodigious variety of periodical ebbs and flows may be produced by underground canals, which are extremely fimple and probable.

374 Account of fome pneumatic engines.

We fhall conclude this article with the defcriptions of fome pneumatical machines or engines which have not been particularly noticed under their names in the former volumes of this work.

Bellows are of moft extenfive and important ufe; and it will be of fervice to defcribe fuch as are of uncommon conftruction and great power, fit for the great operations in metallurgy.

It is not the impulfive force of the blaft that is wanted in moft cafes, but merely the copious fupply of air, to produce the rapid combuftion of inflammable matter; and the fervice would be better performed in general if this could be done with moderate velocities, and an extended furface. What are called air-furnaces, where a confiderable furface of inflammable matter is acted on at once by the current which the mere heat of the

Pneumatic Engines.

the expended air has produced, are found more operative in proportion to the air expended than blast furnaces animated by bellows; and we doubt not but that the method proposed by Mr Cotterel (which we have already mentioned) of increasing this current in a melting furnace by means of a dome, will in time supersede the blast furnaces. There is indeed a great impulsive force required in some cases; as for blowing off the scoriæ from the surface of silver or copper in refining furnaces, or for keeping a clear passage for the air in the great iron furnace.

In general, however, we cannot procure this abundant supply of air any other way than by giving it a great velocity by means of a great pressure, so that the general construction of bellows is pretty much the same in all kinds. The air is admitted into a very large cavity, and then expelled from it through a small hole.

The furnaces at the mines having been greatly enlarged; it was necessary to enlarge the bellows also: and the leathern bellows becoming exceedingly expensive, wooden ones were substituted in Germany about the beginning of last century, and from them became general through Europe. They consist of a wooden box ABCPFE (fig. 74. A), which has its top and two sides flat or straight, and the end BAE *e* formed into an arched or cylindrical surface, of which the line FP at the other end is the axis. This box is open below, and receives within it the shallow box KHGNML (fig. B), which exactly fills it. The line FP of the one coincides with FP of the other, and along this line is a set of hinges on which the upper box turns as it rises and sinks. The lower box is made fast to a frame fixed in the ground. A pipe OQ proceeds from the end of it, and terminates at the furnace, where it ends in a small pipe called the *tewer* or *tuyere*. This lower box is open above, and has in its bottom two large valves V, V, opening inwards. The conducting pipe is sometimes furnished with a valve opening outwards, to prevent burning coals from being sucked into the bellows when the upper box is drawn up. The joint along PF is made tight by thin leather nailed along it. The sides and ends of the fixed box are made to fit the sides and curved end of the upper box, so that this last can be raised and lowered round the joint FP without sensible friction, and yet without suffering much air to escape: but as this would not be sufficiently air-tight by reason of the shrinking and warping of the wood, a farther contrivance is adopted. A slender lath of wood, divided into several joints, and covered on the outer edge with very soft leather, is laid along the upper edges of the sides and ends of the lower box. This lath is so broad, that when its inner edge is even with the inside of the box, its outer edge projects about an inch. It is kept in this position by a number of steel wires, which are driven into the bottom of the box, and stand up touching the sides, as represented in figure D, where *a b c* are the wires, and *e* the lath, projecting over the outside of the box. By this contrivance the laths are pressed close to the sides and curved end of the moveable box, and the spring wires yield to all their inequalities. A bar of wood RS is fixed to the upper board, by which it is either raised by machinery, to sink again by its own weight, having an additional load laid on it, or it is forced downward by a crank or wiper of the machinery, and afterwards raised.

Plate CCCCVI.

The operation here is precisely similar to that of blowing with a chamber-bellows. When the board is lifted up, the air enters by the valves V, V, and is expelled at the pipe OQ by depressing the boards. There is therefore no occasion to insist on this point.

These bellows are made of a very great size, AD being 16 feet, AB five feet, and the circular end AE also five feet. The rise, however, is but about 3 or 3½ feet. They expel at each stroke about 90 cubic feet of air, and they make about 8 strokes per minute.

Such are the bellows in general use on the continent. We have adopted a different form in this kingdom, which seems much preferable. We use an iron or wooden cylinder, with a piston sliding along it. This may be made with much greater accuracy than the wooden boxes, at less expence, if of wood, because it may be of coopers work, held together by hoops; but the great advantage of this form is its being more easily made airtight. The piston is surrounded with a broad strap of thick and soft leather, and it has around its edge a deep groove, in which is lodged a quantity of wool. This is called the packing or stuffing, and keeps the leather very closely applied to the inner surface of the cylinder. Iron cylinders may be very neatly bored and smoothed, so that the piston, even when very tight, will slide along it very smoothly. To promote this, a quantity of black lead is ground very fine with water, and a little of this is smeared on the inside of the cylinder from time to time.

The cylinder has a large valve, or sometimes two, in the bottom, by which the atmospheric air enters when the piston is drawn up. When the piston is thrust down, this air is expelled along a pipe of great diameter, which terminates in the furnace with a small orifice.

This is the simplest form of bellows which can be conceived. It differs in nothing but size from the bellows used by the rudest nations. The Chinese smiths have a bellows very similar, being a square pipe of wood ABCDE (fig. 75.), with a square board G which exactly fits it, moved by the handle FG. At the farther end is the blast pipe HK, and on each side of it a valve in the end of the square pipe, opening inwards. The piston is sufficiently tight for their purposes without any leathering.

The piston of this cylinder-bellows is moved by machinery. In some blast engines the piston is simply raised by the machine, and then let go, and it descends by its own weight, and compresses the air below it to such a degree, that the velocity of efflux becomes constant, and the piston descends uniformly: for this purpose it must be loaded with a proper weight. This produces a very uniform blast, except at the very beginning, while the piston falls suddenly and compresses the air: but in most engines the piston rod is forced down the cylinder with a determined motion, by means of a beam, crank, or other contrivance. This gives a more unequal blast, because the motion of the piston is necessarily slow in the beginning and end of the stroke, and quicker in the middle.

But in all it is plain that the blast must be desultory. It ceases while the piston is rising; for this reason it is usual to have two cylinders, as it was formerly usual to have two bellows which worked alternately. Sometimes three or four are used, as at the Carron iron works. This makes a blast abundantly uniform.

[Pneu]matic [Eng]ines.

But an uniform blaſt may be made with a ſingle cylinder, by making it deliver its air into another cylinder, which has a piſton exactly fitted to its bore, and loaded with a ſufficient weight. The blowing cylinder ABCD (fig. 76.) has its piſton P worked by a rod NP, connected by double chains with the arched head of the working beam NO, moving round a gudgeon at R. The other end O of this beam is connected by the rod OP, with the crank PQ of a wheel machine; or it may be connected with the piſton of a ſteam engine, &c. &c. The blowing cylinder has a valve or valves E in its bottom, opening inwards. There proceeds from it a large pipe CF, which enters the regulating cylinder GHKI, and has a valve at top to prevent the air from getting back into the blowing cylinder. It is evident that the air forced into this cylinder muſt raiſe its piſton L, and that it muſt afterwards deſcend, while the other piſton is riſing. It muſt deſcend uniformly, and make a perfectly equable blaſt.

[Pla]te [CCC]CVI.

Obſerve, that if the piſton L be at the bottom when the machine begins to work, it will be at the bottom at the end of every ſtroke, if the *tuyere* T emits as much air as the cylinder ABCD furniſhes; nay, it will lie a while at the bottom, for, while it was riſing, air was iſſuing through T. This would make an interrupted blaſt. To prevent this, the orifice T muſt be leſſened; but then there will be a ſurplus of air at the end of each ſtroke, and the piſton L will riſe continually, and at laſt get to the top, and allow air to eſcape. It is juſt poſſible to adjuſt circumſtances, ſo that neither ſhall happen. This is done eaſier by putting a ſtop in the way of the piſton, and putting a valve on the piſton, or on the conducting pipe KST, loaded with a weight a little ſuperior to the intended elaſticity of the air in the cylinder. Therefore, when the piſton is prevented by the ſtop from riſing, the ſniſting valve, as it is called, is forced open, the ſuperfluous air eſcapes, and the blaſt preſerves its uniformity.

It may be of uſe to give the dimenſions of a machine of this kind, which has worked for ſome years at a very great furnace, and given ſatisfaction.

The diameter of the blowing cylinder is 5 feet, and the length of the ſtroke is 6. Its piſton is loaded with $3\frac{1}{2}$ tons. It is worked by a ſteam-engine whoſe cylinder is 3 feet 4 inches wide, with a ſix feet ſtroke. The regulating cylinder is 8 feet wide, and its piſton is loaded with $8\frac{1}{2}$ tons, making about 2,63 pounds on the ſquare inch; and it is very nearly in equilibrio with the load on the piſton of the blowing cylinder. The conducting pipe KST is 12 inches in diameter, and the orifice of the tuyere was $1\frac{1}{4}$ inches when the engine was erected, but it has gradually enlarged by reaſon of the intenſe heat to which it is expoſed. The ſniſting valve is loaded with 3 pounds on the ſquare inch.

When the engine worked briſkly, it made 18 ſtrokes per minute, and there was always much air diſcharged by the ſniſting valve. When the engine made 15 ſtrokes per minute, the ſniſting valve opened but ſeldom, ſo that things were nearly adjuſted to this ſupply. Each ſtroke of the blowing cylinder ſent in 118 cubic feet of common air. The ordinary preſſure of the air being ſuppoſed $14\frac{3}{4}$ pounds on an inch, the denſity of the air in the regulating cylinder muſt be $\frac{14,75+2.63}{14,75}, =1,1783$, the natural denſity being 1.

Pneumatic Engines.

This machine gives an opportunity of comparing the expence of air with the theory. It muſt (at the rate of 15 ſtrokes) expel 30 cubic feet of air in a ſecond through a hole of $1\frac{1}{4}$ inches in diameter. This gives a velocity of near 2000 feet per ſecond, and of more than 1600 feet for the condenſed air. This is vaſtly greater than the theory can give, or is indeed poſſible; for air does not ruſh into a void with ſo great velocity. It ſhows with great evidence, that a vaſt quantity of air muſt eſcape round the two piſtons. Their united circumferences amount to above 40 feet, and they move in a dry cylinder. It is impoſſible to prevent a very great loſs. Accordingly, a candle held near the edge of the piſton L has its flame very much diſturbed. This caſe, therefore, gives no hold for a calculation; and it ſuggeſts the propriety of attempting to diminiſh this great waſte.

This has been very ingeniouſly done (in part at leaſt) at ſome other furnaces. At Omoah foundery, near Glaſgow, the blowing cylinder (alſo worked by a ſteam engine) delivers its air into a cheſt without a bottom, which is immerſed in a large ciſtern of water, and ſupported at a ſmall height from the bottom of the ciſtern, and has a pipe from its top leading to the tuyere. The water ſtands about five feet above the lower brim of the regulating air-cheſt, and by its preſſure gives the moſt perfect uniformity of blaſt, without allowing a particle of air to get off by any other paſſage beſides the tuyere. This is a very effectual regulator, and muſt produce a great ſaving of power, becauſe a ſmaller blowing cylinder will thus ſupply the blaſt. We have not learned the dimenſions and performance of this engine. We muſt obſerve, that the loſs round the piſton of the blowing cylinder remains undiminiſhed.

A blowing machine was erected many years ago at Chaſtillon in France on a principle conſiderably different, and which muſt be perfectly air-tight throughout. Two cylinders A, B (fig. 77.), loaded with great weights, were ſuſpended at the ends of the lever CD, moving round the gudgeon E. From the top F, G of each there was a large flexible pipe which united in H, from whence a pipe KT led to the tuyere T. There were valves at F and G opening outwards, or into the flexible pipes; and other valves L, M, adjoining to them in the top of each cylinder, opening inwards, but kept ſhut by a ſlight ſpring. Motion was given to the lever by a machine. The operation of this blowing machine is evident. When the cylinder A was pulled down, or allowed to deſcend, the water, entering at its bottom, compreſſed the air, and forced it along the paſſage FHKT. In the mean time, the cylinder B was riſing, and the air entered by the valve M. We ſee that the blaſt will be very unequal, increaſing as the cylinder is immerſed deeper. It is needleſs to deſcribe this machine more particularly, becauſe we ſhall give an account of one which we think perfect in its kind, and which leaves hardly any thing to be deſired in a machine of this ſort. It was invented by Mr John Laurie, land-ſurveyor in Edinburgh, about 15 years ago, and improved in ſome reſpects ſince his death by an ingenious perſon of that city.

Plate CCCCVII.

ABCD (fig. 78.) is an iron cylinder, truly bored within, and evaſated a-top like a cup. EFGH is another, truly turned both without and within, and a ſmall matter leſs than the inner diameter of the firſt cylinder.

This

Pneumatic Engines.

This cylinder is close above, and hangs from the end of a lever moved by a machine. It is also loaded with weights at N. KILM is a third cylinder, whose outside diameter is somewhat less than the inside diameter of the second. This inner cylinder is fixed to the same bottom with the outer cylinder. The middle cylinder is loose, and can move up and down between the outer and inner cylinders without rubbing on either of them. The inner cylinder is perforated from top to bottom by three pipes OQ, SV, PR. The pipes OQ, PR have valves at their upper ends O, P, and communicate with the external air below. The pipe SV has a horizontal part VW, which again turns upwards, and has a valve at top X. This upright part WX is in the middle of a cistern of water *fhkg*. Into this cistern is fixed an air-chest *a*YZ*b*, open below, and having at top a pipe *cde* terminating in the tuyere at the furnace.

When the machine is at rest, the valves X, O, P, are shut by their own weights, and the air-chest is full of water. When things are in this state, the middle cylinder EFGH is drawn up by the machinery till its lower brims F and G are equal with the top RM of the inner cylinder. Now pour in water or oil between the outer and middle cylinders: it will run down and fill the space between the outer and inner cylinders. Let it come to the top of the inner cylinder.

Now let the loaded middle cylinder descend. It cannot do this without compressing the air which is between its top and the top of the inner cylinder. This air being compressed will cause the water to descend between the inner and middle cylinders, and rise between the middle and outer cylinders, spreading into the cup; and as the middle cylinder advances downwards, the water will descend farther within it and rise farther without it. When it has got so far down, and the air has been so much compressed, that the difference between the surface of the water on the inside and outside of this cylinder is greater than the depth of water between X and the surface of the water *fg*, air will go out by the pipe SVW, and will lodge in the air-chest, and will remain there if *c* be shut, which we shall suppose for the present. Pushing down the middle cylinder till the partition touch the top of the inner cylinder, all the air which was formerly between them will be forced into the air-chest, and will drive out water from it. Draw up the middle cylinder, and the external air will open the valves O, P, and again fill the space between the middle and inner cylinders; for the valve X will shut, and prevent the regress of the condensed air. By pushing down the middle cylinder a second time, more air will be forced into the air-chest, and it will at last escape by getting out between its brims Y, Z and the bottom of the cistern; or if we open the passage *c*, it will pass along the conduit *cde* to the tuyere, and form a blast.

The operation of this machine is similar to Mr Haskins's quicksilver pump described by Desaguliers at the end of the second volume of his Experimental Philosophy. The force which condenses the air is the load on the middle cylinder. The use of the water between the inner and outer cylinders is to prevent this air from escaping; and the inner cylinder thus performs the office of a piston, having no friction. It is necessary that the length of the outer and middle cylinders be greater than the depth of the regulator-cistern, that there may be a sufficient height for the water to rise between the middle and outer cylinders, to balance the compressed air, and oblige it to go into the air-chest. A large blast-furnace will require the regulator-cistern five feet deep, and the cylinders about six or seven feet long.

It is in fact a pump without friction, and is perfectly air-tight. The quickness of its operation depends on the small space between the middle cylinder and the two others; and this is the only use of these two. Without these it would be similar to the engine at Chastillon, and operate more unequally and slowly. Its only imperfection is, that if the cylinder begin its motion of ascent or descent rapidly, as it will do when worked by a steam-engine, there will be some danger of water dashing over the top of the inner cylinder and getting into the pipe SV; but should this happen, an issue can easily be contrived for it at V, covered with a loaded valve *v*. This will never happen if the cylinder is moved by a crank.

One blowing cylinder only is represented here, but two may be used.

We do not hesitate in recommending this form of bellows as the most perfect of any, and fit for all uses where standing bellows are required. They will be cheaper than any other sort for common purposes. For a common smith's forge they may be made with square wooden boxes instead of cylinders. They are also easily repaired. They are perfectly tight; and they may be made with a blast almost perfectly uniform, by making the cistern in which the air-chest stands of considerable dimensions. When this is the case, the height of water, which regulates the blast, will vary very little.

This may suffice for an account of blast machines. The leading parts of their construction have been described as far only as was necessary for understanding their operation, and enabling an engineer to erect them in the most commodious manner. Views of complete machines might have amused, but they would not have added to our reader's information.

But the account is imperfect unless we show how their parts may be so proportioned that they shall perform what is expected from them. The engineer should know what size of bellows, and what load on the board or piston, and what size of tuyere, will give the blast which the service requires, and what force must be employed to give them the necessary degree of motion. We shall accomplish these purposes by considering the efflux of the compressed air through the tuyere. The propositions formerly delivered will enable us to ascertain this.

That we may proportion every thing to the power employed, we must recollect, that if the piston of a cylinder employed for expelling air be pressed down with any force p, it must be considered as superadded to the atmospheric pressure P on the same piston, in order that we may compare the velocity v of efflux with the known velocity V with which air rushes into a void. By what has been formerly delivered, it appears that this velocity

$v = \mathrm{V} \times \sqrt{\frac{p}{\mathrm{P} \times p}}$, where P is the pressure of the atmosphere on the piston, and p the additional load laid on it. This velocity is expressed in feet *per* second; and, when

 multiplied

multiplied by the area of the orifice (alſo expreſſed in ſquare feet), it will give us the cubical feet of condenſed air expelled in a ſecond: but the bellows are always to be filled again with common air, and therefore we want to know the quantity of common air which will be expelled; for it is this which determines the number of ſtrokes which muſt be made in a minute, in order that the proper ſupply may be obtained. Therefore recollect that the quantity expelled from a given orifice with a given velocity, is in the proportion of the denſity; and that when D is the denſity of common air produced by the preſſure P, the denſity d produced by the preſſure $P+p$, is $D \times \frac{P+p}{P}$; or if D be made 1, we have $d=\frac{P+p}{P}$.

Therefore, calling the area of the orifice expreſſed in ſquare feet O, and the quantity of common air, or the cubic feet expelled in a ſecond Q, we have $Q=V \times O \times \sqrt{\frac{p}{P+p}} \times \frac{P+p}{P}$.

It will be ſufficiently exact for all practical purpoſes to ſuppoſe P to be 15 pounds on every ſquare inch of the piſton; and p is then conveniently expreſſed by the pounds of additional load on every ſquare inch: we may alſo take $V=1332$ feet.

As the orifice through which the air is expelled is generally very ſmall, never exceeding three inches in diameter, it will be more convenient to expreſs it in ſquare inches; which being the $\frac{1}{144}$ of a ſquare foot, we ſhall have the cubic feet of common air expelled in a ſecond. or $Q=\frac{1332}{144} O \sqrt{\frac{p}{P+p}} \times \frac{P+p}{P}, = O \times 9{,}25 \times \sqrt{\frac{p}{P+p}} \times \frac{P+p}{P}$; and this ſeems to be as ſimple an expreſſion as we can obtain.

This will perhaps be illuſtrated by taking an example in numbers. Let the area of the piſton be four ſquare feet, and the area of the round hole through which the air is expelled be two inches, its diameter being 1,6; and let the load on the piſton be 1728 pounds: this is three pounds on every ſquare inch. We have $P=15$, $p=3$, $P+p=18$, and $O=2$; therefore we will have $Q=2 \times 9{,}25 \times \sqrt{\frac{3}{18}} \times \frac{18}{15}, =9{,}053$ cubic feet of common air expelled in a ſecond. This will however be diminiſhed at leaſt one third by the contraction of the jet; and therefore the ſupply will not exceed ſix cubic feet *per* ſecond. Suppoſing therefore that this blowing machine is a cylinder or priſm of this dimenſion in its ſection, the piſton ſo loaded would (after having compreſſed the air) deſcend about 15 inches in a ſecond: It would firſt ſink $\frac{1}{5}$ of the whole length of the cylinder pretty ſuddenly, till it had reduced the air to the denſity $\frac{18}{15}$, and would then deſcend uniformly at the above rate, expelling ſix cubic feet of common air in a ſecond.

The computation is made much in the ſame way for bellows of the common form, with this additional circumſtance, that as the loaded board moves round a hinge at one end, the preſſure of the load muſt be calculated accordingly. The computation, however, becomes a little intricate, when the form of the loaded board is not rectangular; it is almoſt uſeleſs when the bellows have flexible ſides, either like ſmith's bellows or like organ bellows, becauſe the change of figure during their motion makes continual variation on the compreſſing powers. It is therefore chiefly with reſpect to the great wooden bellows, of which the upper board ſlides down between the ſides, that the above calculation is of ſervice.

The propriety however of this piece of information is evident; we do not know preciſely the quantity of air neceſſary for animating a furnace; but this calculation tells us what force muſt be employed for expelling the air that may be thought neceſſary. If we have fixed on the ſtrength of the blaſt, and the diameter of the cylinder, we learn the weight with which the piſton muſt be loaded; the length of the cylinder determines its capacity, the above calculation tells the expence *per* ſecond; hence we have the time of the piſton's coming to the bottom. This gives us the number of ſtrokes *per* minute: the load muſt be lifted up by the machine this number of times, making the time of aſcent preciſely equal to that of deſcent; otherwiſe the machine will either catch and ſtop the deſcent of the piſton, or allow it to lie inactive for a while of each ſtroke. Theſe circumſtances determine the labour to be performed by the machine, and it muſt be conſtructed accordingly. Thus the engineer will not be affronted by its failure, nor will he expend needleſs power and coſt.

In machines which force the piſton or bellows-board with a certain determined motion, different from what ariſes from their own weight, the computation is extremely intricate. When a piſton moves by a crank, its motion at the beginning and end of each ſtroke is ſlow, and the compreſſion and efflux is continually changing; we can however approximate to a ſtatement of the force required.

Every time the piſton is drawn up, a certain ſpace of the cylinder is filled again with air of the common denſity; and this is expelled during the deſcent of the piſton. A certain number of cubic feet of common air is therefore expelled with a velocity which perhaps continually varies; but there is a medium velocity with which it might have been uniformly expelled, and a preſſure correſponding to this velocity. To find this, divide the area of the piſton by the area of the blaſt-hole (or rather by this area multiplied by 0,613, in order to take in the effect of the contracted jet), and multiply the length of the ſtroke performed in a ſecond by the quotient ariſing from this diviſion; the product is the medium velocity of the air (of the natural denſity). Then find by calculation the height through which a heavy body muſt fall in order to acquire this velocity; this is the height of a column of homogeneous air which would expel it with this velocity. The weight of this column is the leaſt force that can be exerted by the engine: but this force is too ſmall to overcome the reſiſtance in the middle of the ſtroke, and it is too great even for the end of the ſtroke, and much too great for the beginning of it. But if the machine is turned by a very heavy water-wheel, this will act as a regulator, accumulating in itſelf the ſuperfluous force during the too favourable poſitions of the crank, and exerting it by its *vis inſita* during the time of greateſt effort. A force not greatly exceeding the weight of this column of air will therefore ſuffice. On the other hand, if the ſtrength of the blaſt be determined, which is the general ſtate of the problem, this

Pneumatic Engines.

determines the degree of condenſation of the air, and the load on the ſquare inch of the piſton, or the mean force which the machine muſt exert on it. A table, which will be given preſently, determines the cubic feet of common air expelled in a ſecond, correſponding to this load. This combined with the propoſed dimenſions of the cylinder, will give the deſcent of the piſton or the length of the ſtroke.

Theſe general obſervations apply to all forms of bellows; and without a knowledge of them no perſon can erect a machine for working them without total uncertainty or ſervile imitation. In order, therefore, that they may be uſeful to ſuch as are not accuſtomed to the management of even theſe ſimple formulæ, we inſert the following ſhort table of the velocity and quantity of air diſcharged from a cylinder whoſe piſton is loaded with the pounds contained in the firſt column on every ſquare inch. The ſecond column contains the velocity with which the *condenſed air* ruſhes out through any *ſmall* hole; and the third column is the cubic feet diſcharged from a hole whoſe area is a ſquare inch; column fourth contains the mean velocity of air of the common denſity; and column fifth is the cubic feet of common air diſcharged; the ſixth column is the height in inches at which the force of the blaſt would ſupport a column of water if a pipe were inſerted into the ſide of the cylinder. This is an extremely proper addition to ſuch machines, ſhowing at all times the power of the machines, and teaching us what intenſity of blaſt is employed for different purpoſes. The table is computed from the ſuppoſition that the ordinary preſſure of the air is 15 pounds on a ſquare inch. This is ſomewhat too great, and therefore the velocities are a little too ſmall; but the quantities diſcharged will be found about $\frac{1}{3}$ too great (without affecting the velocities) on account of the convergency of the ſtream.

I	II	III	IV	V	VI
$\frac{1}{2}$	239	1,66	247	1,72	14
1	333	2,31	355	2,47	27
$1\frac{1}{2}$	404	2,79	437	3,05	40
2	457	3,17	518	3,60	54
$2\frac{1}{2}$	500	3,48	584	4,2	68
3	544	3,76	653	4,53	82
$3\frac{1}{2}$	582	4,03	715	4,98	95
4	611	4,24	774	5,38	109
$4\frac{1}{2}$	642	4,46	822	5,75	122
5	666	4,67	888	6,17	136
$5\frac{1}{2}$	693	4,84	950	6,49	150
6	711	5,06	997	6,92	163

This table extends far beyond the limits of ordinary uſe, very few blaſt-furnaces having a force exceeding 60 inches of water.

Plate CCCCVII.

We ſhall conclude this account of blowing machines with a deſcription of a ſmall one for a blow-pipe. Fig. 79. ABCD, is a veſſel containing water, about two feet deep. EFGH is the air-box of the blower open below, and having a pipe ILK riſing up from it to a convenient height; an arm ON which graſps this pipe carries the lamp N: the blow-pipe LM comes from the top of the upright pipe. PKQ is the feeding pipe reaching near to the bottom of the veſſel.

Water being poured into the veſſel below, and its cover being put on, which fits the upright pipe, and touches two ſtuds *a*, *a*, projecting from it, blow in a quantity of air by the feeding pipe PQ; this expels the water from the air-box, and occaſions a preſſure which produces the blaſt through the blow-pipe M.

Pneumatic Engines.

In n° 54. of this article, we mentioned an application which has been made of Hero's fountain, at Chemnitz in Hungary, for raiſing water from the bottom of a mine. We ſhall now give an account of this very ingenious contrivance.

In fig. 80. B repreſents the ſource of water elevated above the mouth of the pit 136 feet. From this there is led a pipe B*b*CD four inches diameter. This pipe enters the top of a copper cylinder *b c d e*, $8\frac{1}{2}$ feet high, five feet diameter, and two inches thick, and it reaches to within four inches of the bottom; it has a cock at C. This cylinder has a cock at F, and a very large one at E. From the top *b e* proceeds a pipe GHH′ two inches in diameter, which goes down the pit 96 feet, and is inſerted into the top of another braſs cylinder *f g h i*, which is $6\frac{1}{2}$ feet high, four feet diameter, and two inches thick, containing 83 cubic feet, which is very nearly one half of the capacity of the other, viz. of 170 cubic feet. There is another pipe NI of four inches diameter, which riſes from within four inches of the bottom of this lower cylinder, is ſoldered into its top, and riſes to the trough NO, which carries off the water from the mouth of the pit. This lower cylinder communicates at the bottom with the water L which collects in the drains of the mine. A large cock K ſerves to admit or exclude this water; another cock M, at the top of this cylinder, communicates with the external air.

Now ſuppoſe the cock C ſhut, and all the reſt open; the upper cylinder will contain air, and the lower cylinder will be filled with water, becauſe it is ſunk ſo deep that its top is below the uſual ſurface of the mine-waters. Now ſhut the cocks F, E, M, K, and open the cock C. The water of the ſource B muſt run in by the orifice D, and riſe in the upper cylinder, compreſſing the air above it and along the pipe GHH′, and thus acting on the ſurface of the water in the lower cylinder. It will therefore cauſe it to riſe gradually in the pipe IN, where it will always be of ſuch a height that its weight balances the elaſticity of the compreſſed air. Suppoſe no iſſue given to the air from the upper cylinder, it would be compreſſed into $\frac{1}{5}$th of its bulk by the column of 136 feet high; for a column of 34 feet nearly balances the ordinary elaſticity of the air. Therefore, when there is an iſſue given to it through the pipe GHH′, it will drive the compreſſed air along this pipe, and it will expel water from the lower cylinder. When the upper cylinder is full of water, there will be 34 cubic feet of water expelled from the lower cylinder. If the pipe IN had been more than 136 feet long, the water would have riſen 136 feet, being then in equilibrio with the water in the feeding pipe B*b*CD (as was ſhown in n° 52.), by the intervention of the elaſtic air; but no more water would have been expelled from the lower cylinder than what fills this pipe. But the pipe being only 96 feet high, the water will be thrown out at N with a very great velocity. If it were not for the great obſtructions which water and air muſt meet with in their paſſage along pipes, it would iſſue at N with a velocity of more than 50 feet per ſecond. It

iſſues

issues much more slowly, and at last the upper cylinder is full of water, and the water would enter the pipe GH and enter the lower cylinder, and without displacing the air in it, would rise through the discharging pipe IN, and run off to waste. To prevent this there hangs in the pipe HG a cork ball or double cone, by a brass wire which is guided by holes in two cross pieces in the pipe HG. When the upper cylinder is filled with water, this cork plugs up the orifice G, and no water is wasted; the influx at D now stops. But the lower cylinder contains compressed air, which would balance water in a discharging pipe 136 feet high, whereas IN is only 96. Therefore the water will continue to flow at N till the air has so far expanded as to balance only 96 feet of water, that is, till it occupies $\frac{1}{2}$ of its ordinary bulk, that is, $\frac{1}{4}$ of the capacity of the upper cylinder, or $42\frac{1}{2}$ cubic feet. Therefore $42\frac{1}{2}$ cubic feet will be expelled, and the efflux at N will cease; and the lower cylinder is about $\frac{1}{4}$ full of water. When the attending workman observes this, he shuts the cock C. He might have done this before, had he known when the orifice G was stopped; but no loss ensues from the delay. At the same time the attendant opens the cock E, the water issues with great violence, being pressed by the condensed air from the lower cylinder. It therefore issues with the sum of its own weight and of this compression. These gradually decrease together, by the efflux of the water and the expansion of the air; but this efflux stops before all the water has flowed out; for there is $42\frac{1}{2}$ feet of the lower cylinder occupied by air. This quantity of water remains, therefore, in the upper cylinder nearly: the workman knows this, because the discharged water is received first of all into a vessel containing $\frac{3}{4}$ of the capacity of the upper cylinder. Whenever this is filled, the attendant opens the cock K by a long rod which goes down the shaft; this allows the water of the mine to fill the lower cylinder, allows the air to get into the upper cylinder, and this allows the remaining water to run out of it.

And thus every thing is brought into its first condition; and when the attendant sees no more water come out at E, he shuts the cocks E and M, and opens the cock C, and the operation is repeated.

There is a very surprising appearance in the working of this engine. When the efflux at N has stopped, if the cock F be opened, the water and air rush out together with prodigious violence, and the drops of water are changed into hail or lumps of ice. It is a sight usually shown to strangers, who are desired to hold their hats to receive the blast of air: the ice comes out with such violence as frequently to pierce the hat like a pistol bullet. This rapid congelation is a remarkable instance of the general fact, that air by suddenly expanding, generates cold, its capacity for heat being increased. Thus the peasant cools his broth by blowing over the spoon, even from warm lungs: a stream of air from a pipe is always cooling.

The above account of the procedure in working this engine shows that the efflux both at N and E becomes very slow near the end. It is found convenient, therefore not to wait for the complete discharges, but to turn the cocks when about 30 cubic feet of water have been discharged at N: more work is done in this way. A gentleman of great accuracy and knowledge of these subjects took the trouble, at our desire, of noticing particularly the performance of the machine. He observed that each stroke, as it may be called, took up about three minutes and $\frac{1}{3}$; and that 32 cubic feet of water were discharged at N, and 66 were expended at E. The expence therefore is 66 feet of water falling 136 feet, and the performance is 32 raised 96, and they are in the proportion of 66×136 to 32×96, or of 1 to 0,3422, or nearly as 3 to 1. This is superior to the performance of the most perfect undershot mill, even when all friction and irregular obstructions are neglected; and is not much inferior to any overshot pump-mill that has yet been erected. When we reflect on the great obstructions which water meets with in its passage through long pipes, we may be assured that, by doubling the size of the feeder and discharger, the performance of the machine will be greatly improved; we do not hesitate to say, that it would be increased $\frac{1}{5}$: it is true that it will expend more water; but this will not be nearly in the same proportion; for most of the deficiency of the machine arises from the needless velocity of the first efflux at N. The discharging pipe ought to be 110 feet high, and not give sensibly less water.

Then it must be considered how inferior in original expence this simple machine must be to a mill of any kind which would raise 10 cubic feet 96 feet high in a minute, and how small the repairs on it need be, when compared with a mill.

And, lastly, let it be noticed, that such a machine can be used where no mill whatever can be put in motion. A small stream of water, which would not move any kind of wheel, will here raise $\frac{1}{5}$ of its own quantity to the same height; working as fast as it is supplied.

For all these reasons, we think that the Hungarian machine eminently deserves the attention of mathematicians and engineers, to bring it to its utmost perfection, and into general use. There are situations where this kind of machine may be very useful. Thus, where the tide rises 17 feet, it may be used for compressing air to $\frac{7}{8}$ of its bulk; and a pipe leading from a very large vessel inverted in it, may be used for raising the water from a vessel of $\frac{1}{7}$ of its capacity 17 feet high; or if this vessel has only $\frac{1}{18}$ of the capacity of the large one set in the tide-way, two pipes may be led from it; one into the small vessel, and the other into an equal vessel 16 feet higher, which receives the water from the first. Thus $\frac{1}{18}$ of the water may be raised 34 feet, and a smaller quantity to a still greater height; and this with a kind of power that can hardly be applied in any other way. Machines of this kind are described by Schottus, Sturmius, Leupold, and other old writers; and they should not be forgotten, because opportunities may offer of making them highly useful. A gentleman's house in the country may thus be supplied with water by a machine that will cost little, and hardly go out of repair.

The last pneumatical engine which we shall speak of at present is the common fanners, used for winnowing grain, and for drawing air out of a room: and we have but few observations to make on them.

The wings of the fanners are inclosed in a cylinder or drum, whose circular sides have a large opening BDE (fig. 81.) round the centre, to admit the air. By turning the wings rapidly round, the air is hurried round along with them, and thus acquires a centrifugal tendency, by which it presses strongly on the outer rim of the drum: this

Plate CCCCVII.

Pneumatic Engines.

this is gradually detached from the circle as at KI, and terminated in a trunk IHGF, which goes off in a tangential direction: the air therefore is driven along this passage.

If the wings were disposed in planes passing through the axis C, the compression of the air by their anterior surface would give it some tendency to escape in every direction, and would obstruct in some degree the arrival of more air through the side-holes. They are therefore reclined a little backward, as represented in the figure. It may be shown that their best form would be that of a hyperbolic spiral *a b c;* but the straight form approaches sufficiently near to the most perfect shape.

Much labour is lost, however, in carrying the air round those parts of the drum where it cannot escape. The fanners would either draw or discharge almost twice as much air if an opening were made all round one side. This could be gradually contracted (where required for winnowing) by a surrounding cone, and thus directed against the falling grain: this has been verified by actual trial. When used for drawing air out of a room for ventilation, it would be much better to remove the outer side of the drum entirely, and let the air fly freely off on all sides; but the flat sides are necessary, in order to prevent the air from arriving at the fanners any other way but through the central holes, to which trunks should be fitted leading to the apartment which is to be ventilated.

Pneumatosis || Pococke.

PNEUMATOSIS. See MEDICINE, n° 336.

PNEUMONIA. See MEDICINE, n° 183.

PNEUMONICS, in pharmacy, medicines proper in diseases of the lungs, in which respiration is affected.

PO, a large and celebrated river of Italy, which has its source at mount Vise in Piedmont, and on the confines of Dauphiny. It runs through Piedmont, Montferrat, the Milanese, and duchy of Mantua; from thence it runs to the borders of the Parmezan, and a part of the Modenese; and having entered the Ferarese, it begins to divide at Ficheruolo, and proceeds to discharge itself into the Gulf of Venice by four principal mouths. As it passes along, it receives several rivers, and often overflows its banks, doing a great deal of mischief: the reason of which is, that most of those rivers descend from the Alps, and are increased by the melting of the snow.

POA, MEADOW-GRASS: A genus of the digynia order, belonging to the pentandria class of plants; and in the natural method ranking under the fourth order, *Gramina.* The calyx is bivalved and multiflorous; the spicula or partial spike is ovate, with the valvules scarious and a little sharp, or thin on the margin. There are 20 species; most of them grasses, and very agreeable food for cattle; for one species, which grows in marshes, the cattle will frequently go so deep as to endanger their lives. This is called the *aquatica*, or *water reed-grass.* It is the largest of the British grasses, growing to the height of five or six feet. The leaves are smooth, and half an inch wide or more. The panicle is eight or ten inches long, greatly branched, and decked with numerous spicula: these are of a reddish brown colour intermixed with green, of a compressed lanceolate form, imbricated with about six flowers for the most part, but varying from five to ten.

POCHETTI. See BARBATELLI.

POCOCKE (Dr Edward), one of the most learned men in the oriental tongues in Europe, was the eldest son of the Rev. Edward Pococke; and was born at Oxford in 1604, where he was also bred. In 1628 he was admitted probationer-fellow of his college, and about the same time had prepared an edition of the Second Epistle of St Peter, the Second and Third of St John, and that of St Jude, in Syriac and Greek, with a Latin Translation and Notes. In 1629 he was ordained priest, and appointed chaplain to the English merchants at Aleppo, where he continued five or six years; in which time he distinguished himself by his fortitude and zeal while the plague raged there. At length returning to England, he was in 1636 appointed reader of the Arabic lectures founded by archbishop Laud. Three years after he went to Constantinople, where he prosecuted his studies of the eastern tongues, and procured many valuable manuscripts. After near four years stay in that city, he embarked in 1640; and taking Paris in his way, visited Gabriel Sionita the famous Maronite, and Hugo Grotius. In 1643 he was presented to the rectory of Childrey in Berks; and about three years after married the daughter of Thomas Burdett, Esq. About the middle of 1647 he obtained the restitution of the salary of his Arabic lecture, which had been detained from him about three years. In 1648 king Charles I. who was then prisoner in the isle of Wight, nominated Mr Pococke to the professorship of Hebrew, and the canonry of Christ-church annexed to it; but in 1650 he was ejected from his canonry for refusing to take the engagement, and soon after a vote passed for depriving him of his Hebrew and Arabic lectures; but several governors of houses, &c. presenting a petition in his favour, he was suffered to enjoy both these places. He had some years before published his *Specimen Historiæ Arabum;* and now appeared his *Porta Mosis:* and soon after the English Polyglot edition of the Bible, to which he had largely contributed, and also Eutychius's Annals, with a Latin version. At the Restoration, he was restored to the canonry of Christ-church, and also received the degree of doctor of divinity. He then published his Arabic version of Grotius's Treatise of the Truth of the Christian Religion; and an Arabic poem intitled *Lamiato'l Ajam*, with a Latin translation and notes. Soon after he published Gregory Abul Pharajius's *Historia Dynastiarum.* In 1674 he published an Arabic version of the chief parts of the Liturgy of the Church of England; and a few years after his Commentary on the Prophecies of Micah, Malachi, Hosea, and Joel. This great man died in 1691, after having been for many years confessedly the first person in Europe for eastern learning; and was no less worthy of admiration for his uncommon modesty and humility, and all the virtues that can adorn a Christian. His theological works were republished at London in 1740, in two volumes in folio.

PODAGRA, or the GOUT. See MEDICINE, n° 211.

PODALIRIUS,

PODALIRIUS, son of Æsculapius and Epione, was one of the pupils of the Centaur Chiron, under whom he made himself such a master of medicine, that during the Trojan war the Greeks invited him to their camp to stop a pestilence which had baffled the skill of all their physicians. Some suppose, however, that he went to the Trojan war, not in the capacity of a physician in the Grecian army, but as a warrior, attended by his brother Machaon, in 30 ships, with soldiers from Œchalia, Ithome, and Trica. At his return Podalirius was shipwrecked on the coast of Caria, where he cured of the falling sickness a daughter of the king of the place. He fixed his habitation there; and built two towns, one of which he called *Syrna*, after his wife. The Carians, on his death, built him a temple, and paid him divine honours.

PODEX, in anatomy, the same with ANUS.

PODGRAJE. See ASISIA.

PODOLIA, a province of Poland, bounded on the east by Volhinia and the river Ukrain; on the north and north-east, by Budsiac Tartary; on the south-east, by the river Niester, which separates it from Bessarabia and Moldavia in European Turkey on the south-west; and by the province of Red Russia on the north-west. It is usually divided into the Upper and Lower. In the Upper, which is the western part, the chief town is Kamieck, the capital of Podolia, and of a palatinate. In the Lower, or eastern part of Podolia, the chief town is Bracklaw, the capital of a palatinate.

PODOPHYLLUM, in botany: A genus of the monogynia order, belonging to the polyandria class of plants; and in the natural method ranking under the 27th order, *Rhœadæ*. The corolla has nine petals; the calyx triphyllous; the berry unilocular, crowned with the stigma.

PODURA, or SPRING TAIL, in zoology, a genus of insects of the order of aptera. *Linn. Syst. Nat.* p. 1013. They have six feet formed for running; two eyes composed of eight facets; a tail forked, bent under the body, elastic, and acting like a spring; the antennæ are long and setaceous. "This genus is distinguished (says Barbut) into several species. Some inhabit still waters, leaping and walking with ease on the surface of that element. They assemble in troops in the morning, on the banks of pools, fish-ponds, and reservoirs; others are found in damp places, under leaves, bark, and stones; others among heaps of rotten wood, mushrooms, and in melon-beds. In Lapland, they are seen running upon the snow, but when it begins to melt they perish. The podura, by its elasticity, eludes the eager grasp of the naturalist. Its hard forky tail is a kind of spring, by means of which the body of the animal is thrown up into the air." The podura villosa is one of the largest species found in Britain, and appears to be of a brown sooty colour, though it is really of a yellow brown, interspersed throughout with black-coloured spots and streaks. The head and thorax are hairy, and stick to the fingers when touched: the abdomen is smooth: the antennæ, consisting of four articulations, are as long as two-thirds of the body. It is commonly found under stones.

POE-BIRD, in ornithology, is an inhabitant of some of the South Sea islands, where it is held in great esteem and veneration by the natives. It goes by the name of *kogo* in New Zealand; but it is better known by that of *poë-bird*. It is somewhat less than our blackbird. The feathers are of a fine mazarine blue, except those of its neck, which are of a most beautiful silver grey, and two or three short white ones which are on the pinion-joint of the wing. Under its throat hang two little tufts of curled snow-white feathers, called its *poies* (the Otaheitian word for ear-rings); which occasioned the name of *poë-bird* being given to it. It is remarkable for the sweetness of its note, as well as the beauty of its plumage. Its flesh is also delicate food.

PŒCILE was a famous portico at Athens, which received its name from the variety (ποικιλος) of paintings which it contained. Zeno kept his school there; and there also the stoics received their lessons, whence their name, ἀ στοα, *a porch*. The Pœcile was adorned, among many others, with a picture of the siege and sacking of Troy, the battle of Theseus against the Amazons, and the fight between the Lacedæmonians and Athenians at Œnoe in Argolis. The only reward which Miltiades obtained after the battle of Marathon was to have his picture drawn more conspicuous than that of the rest of the officers that fought with him, in the representation which was made of the engagement, and which was hung up in the Pœcile in commemoration of that celebrated victory.

POEM, a poetical composition. See POETRY.

POESTUM, or POSIDONIA, an ancient city of Grecia Magna, now part of the kingdom of Naples. It was founded by one of those colonies from Greece which in the early ages established themselves in Italy; and it flourished before the foundation of Rome itself. It was destroyed by the Goths on the decline of the Roman empire, who in their barbarous zeal for the Christian religion overturned every place of Pagan worship which was exposed to their ravages. Since that time it has been in ruins; and these ruins were unknown till they were discovered in the following manner: "In the year 1755 (says the author of the *Antiquities, History, and Views of Poestum*), an apprentice to a painter at Naples, who was on a visit to his friends at Capaccio, by accident took a walk to the mountains which surround the territory of Poestum. The only habitation he perceived was the cottage of a farmer, who cultivated the best part of the ground, and reserved the rest for pasture. The ruins of the ancient city made a part of this view, and particularly struck the eyes of the young painter; who, approaching nearer, saw with astonishment walls, towers, gates, and temples. Upon his return to Capaccio, he consulted the neighbouring people about the origin of these monuments of antiquity. He could only learn, that this part of the country had been uncultivated and abandoned during their memory; that about ten years before, the farmer, whose habitation he had noticed, established himself there; and that having dug in many places and searched among the ruins that lay round him, he had found treasures sufficient to enable him to purchase the whole. At the painter's return to Naples, he informed his master of these particulars, whose curiosity was so greatly excited by the description, that he took a journey to the place, and made drawings of the principal views. These were shown to the king of Naples, who ordered the ruins to be cleared, and Poestum arose from the obscurity in which it had remained for upwards of 700 years, as little known to the neighbouring inhabitants as to travellers."

Our author gives the following description of it in its

Pœstum.

its present state. It is, says he, of an oblong figure, about two miles and a half in circumference. It has four gates, which are opposite to each other. On the key-stone of the arch of the north gate, on the outside, is the figure of Neptune in basso relievo, and within a hippocampus. The walls which still remain are composed of very large cubical stones, and are extremely thick, in some parts 18 feet. That the walls have remained unto this time is owing to the very exact manner in which the stones are fitted to one another (a circumstance observed universally in the masonry of the ancients), and perhaps in some measure to a stalactical concretion which has grown over them. On the walls here and there are placed towers of different heights; those near the gates being much higher and larger than the others, and evidently of modern workmanship. He observes, that, from its situation among marshes, bituminous and sulphureous springs, Poestum must have been unwholesome; a circumstance mentioned by Strabo, *Morbosam eam facit fluvius in paludes diffusus.* In such a situation the water must have been bad. Hence the inhabitants were obliged to convey that necessary of life from purer springs by means of aqueducts, of which many vestiges still remain.

The principal monuments of antiquity are a theatre, an amphitheatre, and three temples. The theatre and amphitheatre are much ruined. The first temple is hexastylos, and amphiprostylos. At one end, the pilasters and two columns which divided the cella from the pronaos are still remaining. Within the cella are two rows of smaller columns, with an architrave, which support the second order. This temple our author takes to be of that kind called by Vitruvius *hyphæthros*, and supports his opinion by a quotation from that author. The second temple is also amphiprostylos: it has nine columns in front and 18 in flank, and seems to be of that kind called by Vitruvius *pseudodipteros*. The third is likewise amphiprostylos. It has six columns in front and 13 in flank. Vitruvius calls this kind of temple *peripteros*. "The columns of these temples (says our author) are of that kind of Doric order which we find employed in works of the greatest antiquity. They are hardly five diameters in height. They are without bases, which also has been urged as a proof of their antiquity; but we do not find that the ancients ever used bases to this order, at least till very late. Vitruvius makes no mention of bases for this order: and the only instance we have of it is in the first order of the colisæum at Rome, which was built by Vespasian. The pillars of these temples are fluted with very shallow flutings in the manner described by Vitruvius. The columns diminish from the bottom, which was the most ancient method almost universally in all the orders. The columns have astragals of a very singular form; which shows the error of those who imagine that this member was first invented with the Ionic order, to which the Greeks gave an astragal, and that the Romans were the first who applied it to the Doric. The echinus of the capitol is of the same form with that of the temple of Corinth described by Le Roy." See *Swinburne's Travels in the Two Sicilies*, vol. ii. p. 131—140.

Pœstum, Poet.

POET, the author of a poem. See the article Poetry.

Provencal Poets. See Troubadours.

POETRY.

AMIDST those thick clouds which envelope the first ages of the world, reason and history throw some lights on the origin and primitive employment of this divine art. Reason suggests, that before the invention of letters, all the people of the earth had no other method of transmitting to their descendants the principles of their worship, their religious ceremonies, their laws, and the renowned actions of their sages and heroes, than by poetry; which included all these objects in a kind of hymns that fathers sung to their children, in order to engrave them with indelible strokes in their hearts. History not only informs us, that Moses and Miriam, the first authors that are known to mankind, sung, on the borders of the Red Sea, a song of divine praise, to celebrate the deliverance which the Almighty had vouchsafed to the people of Israel, by opening a passage to them through the waters; but it has also transmitted to us the song itself, which is at once the most ancient monument and a master-piece of poetic composition.

1 Origin of poetry.

The Greeks, a people the most ingenious, the most animated, and in every sense the most accomplished, that the world ever produced—strove to ravish from the Hebrews the precious gift of poetry, which was vouchsafed them by the Supreme Author of all nature, that they might ascribe it to their false deities. According to their ingenious fictions, Apollo became the god of poetry, and dwelt on the hills of Phocis, Parnassus, and Helicon, whose feet were washed by the waters of Hyppocrene, of which each mortal that ever drank was seized with a sacred delirium. The immortal swans floated on its waves. Apollo was accompanied by the Muses—those nine learned sisters—the daughters of Memory: and he was constantly attended by the Graces. Pegasus, his winged courser, transported him with a rapid flight into all the regions of the universe. Happy emblems! by which we at this day embellish our poetry, as no one has ever yet been able to invent more brilliant images.

The literary annals of all nations afford vestiges of poetry from the remotest ages. They are found among the most savage of the ancient barbarians, and the most desolate of all the Americans. Nature asserts her rights in every country and every age. Tacitus mentions the verses and the hymns of the Germans, at the time when that rough people yet inhabited the woods, and while their manners were still savage. The first inhabitants of Runnia, and the other northern countries, those of Gaul, Albion, Iberia, Ausonia, and other nations of Europe, had their poetry, as well as the ancient people of Asia, and of the known borders of Africa. But the simple productions of nature have constantly something unformed, rough, and savage. The Divine Wisdom appears to have placed the ingenious and polished part of mankind on the earth, in order to refine that which comes from her bosom rude and imperfect: and thus art has polished poetry, which issued quite naked and savage from the brains of the first of mankind.

But what is Poetry? It would be to abridge the limits

2 Definition of poetry.

limits of the poetic empire, to contract the sphere of this divine art, should we say, in imitation of all the dictionaries and other treatises on versification, That *poetry is the art of making verses, of lines or periods that are in rhyme or metre.* This is rather a grammatical explanation of the word, than a real definition of the thing, and it would be to degrade poetry thus to define it. The father of criticism has denominated poetry τεχνη μιμητικη, *an imitative art*: but this, though just in itself, is too general for a definition, as it does not discriminate poetry from other arts which depend equally on imitation. The justest definition seems to be that given by Baron Bielfield *, *That poetry is the art of expressing our thoughts by fiction.* In fact, it is after this manner (if we reflect with attention) that all the metaphors and allegories, all the various kinds of fiction, form the first materials of a poetic edifice: it is thus that all images, all comparisons, allusions, and figures, especially those which personify moral subjects, as virtues and vices, concur to the decorating of such a structure. A work, therefore, that is filled with invention, that incessantly presents images which render the reader attentive and affected, where the author gives interesting sentiments to every thing that he makes speak, and where he makes speak by sensible figures all those objects which would affect the mind but weakly when clothed in a simple prosaic style, such a work is a poem. While that, though it be in verse, which is of a didactic, dogmatic, or moral nature, and where the objects are presented in a manner quite simple, without fiction, without images or ornaments, cannot be called *poetry*, but merely a work in verse; for the art of reducing thoughts, maxims, and periods, into rhyme or metre, is very different from the art of poetry.

* Elem. of Univ. Erud.

An ingenious fable, a lively and interesting romance, a comedy, the sublime narrative of the actions of a hero, such as the Telemachus of M. Fenelon, though written in prose, but in measured prose, is therefore a work of poetry: because the foundation and the superstructure are the productions of genius, as the whole proceeds from fiction; and truth itself appears to have employed an innocent and agreeable deception to instruct with efficacy. This is so true, that the pencil also, in order to please and affect, has recourse to fiction; and this part of painting is called the *poetic composition of a picture.* It is therefore by the aid of fiction that poetry, so to speak, paints its expressions, that it gives a body and a mind to its thoughts, that it animates and exalts that which would otherwise have remained arid and insensible. It is the peculiar privilege of poetry to exalt inanimate things into animals, and abstract ideas into persons. The former licence is so common, that it is now considered as nothing more than a characteristical dialect appropriated by the poets to distinguish themselves from the writers of prose; and it is at the same time so essential, that we question much if this species of composition could subsist without it: for it will perhaps, upon examination, be found, that in every poetical description some of the qualities of Animal Nature are ascribed to things not having life. Every work, therefore, where the thoughts are expressed by fictions or images, is poetic; and every work where they are expressed naturally, simply, and without ornament, although it be in verse, is prosaic.

Verse, however, is not to be regarded as foreign or superfluous to poetry. To reduce those images, those fictions, into verse, is one of the greatest difficulties in poetry, and one of the greatest merits in a poem: and for these reasons, the cadence, the harmony of sounds, particularly that of rhyme, delight the ear to a high degree, and the mind insensibly repeats them while the eye reads them. There results therefore a pleasure to the mind, and a strong attachment to these ornaments: but this pleasure would be frivolous, and even childish, if it were not attended by a real utility. Verses were invented in the first ages of the world, merely to aid and to strengthen the memory: for cadence, harmony, and especially rhyme, afford the greatest assistance to the memory that art can invent; and the images, or poetic fictions, that strike our senses, assist in graving them with such deep traces in our minds, as even time itself frequently cannot efface. How many excellent apophthegms, sentences, maxims, and precepts, would have been buried in the abyss of oblivion, if poetry had not preserved them by its harmony? To give more efficacy to this lively impression, the first poets sung their verses, and the words and phrases must necessarily have been reduced, at least to cadence, or they could not have been susceptible of musical expression. One of the great excellencies, therefore, though not a necessary constituent, of poetry, consists in its being expressed in verse. See Part III.

3 Verse, though not essential to poetry, one of its excellencies.

Part I. GENERAL PRINCIPLES of the ART.

Sect. I. *Of the Essence and End of Poetry.*

4 Essence of poetry.

The *essence* of *Polite Arts* in general, and consequently of poetry in particular, consists in *expression*; and we think that, to be poetic, the expression must necessarily arise from *fiction*, or invention. (See the article Art, particularly from n° 12. to the end.) This invention, which is the fruit of happy genius alone, arises, 1. From the subject itself of which we undertake to treat: 2. From the manner in which we treat that subject, or the species of writing of which we make use: 3. From the plan that we propose to follow in conformity to this manner; and, 4. From the method of executing this plan in its full detail. Our first guides, the ancients, afford us no lights that can elucidate all these objects in general. The precepts which Aristotle lays down, relate to epic and dramatic poetry only: and which, by the way, confirms our idea, that antiquity itself made the essence of poetry to consist in fiction, and not in that species of verse which is destitute of it, or in that which is not capable of it. But since this art has arrived to a great degree of perfection; and as poetry, like electricity, communicates its fire to every thing it touches, and animates and embellishes whatever it treats; there seems to be no subject in the universe to which poetry cannot be applied, and which it cannot render equally brilliant and pleasing. From this universality of poetry, from its peculiar property of expression by fiction, which is applicable to all subjects, have arisen its different species, of which a particular description will be given in the *second* part.

Horace, in a well-known verse, has been supposed to declare

Of Invention

declare the *end* of poetry to be twofold, to please, or to instruct:

Aut prodesse volunt, aut delectare poetæ.

5 End of poetry.

But Dr Beattie * maintains, that the ultimate end of this art is to please; instruction being only one of the means (and not always a necessary one) by which that ultimate end is to be accomplished. The passage rightly understood, he observes, will not appear to contain any thing inconsistent with this doctrine. The author is there stating a comparison between the Greek and Roman writers, with a view to the poetry of the stage; and, after commending the former for their correctness, and for the liberal spirit wherewith they conducted their literary labours, and blaming his countrymen for their inaccuracy and avarice, he proceeds thus: "The ends proposed by our dramatic poets (or by poets in general) are, to please, to instruct, or to do both. When instruction is your aim, let your moral sentences be expressed with brevity, that they may be readily understood, and long remembered: where you mean to please, let your fictions be conformable to truth, or probability. The elder part of your audience (or readers) have no relish for poems that give pleasure only without instruction; nor the younger for such writings as give instruction without pleasure. He only can secure the universal suffrage in his favour, who blends the useful with the agreeable, and delights at the same time that he instructs the reader. Such are the works that bring money to the bookseller, that pass into foreign countries, and perpetuate the author's name through a long succession of ages †."—Now, what is the meaning of all this? What, but that to the *perfection* of dramatic poetry (or, if you please, of poetry in general) both sound morals and beautiful fiction are requisite? But Horace never meant to say, that instruction, as well as pleasure, is necessary to give to any composition the *poetical character*; or he would not in another place have celebrated with so much affection and rapture the melting strains of Sappho, and the playful genius of Anacreon ‡,—two authors transcendently sweet, but not remarkably instructive. We are sure, that pathos, and harmony, and elevated language, were, in Horace's opinion, essential to poetry §; and of these decorations nobody will affirm that instruction is the end, who considers that the most instructive books in the world are written in plain prose.

* *Essays on Poetry and Music*, Part I. chap. i.

† *Hor. Ar. Poet.* 333—347.

‡ *Hor. Carm.* lib. 4. ode 9.

§ *Hor. Sat.* lib. 1. sat. 4 ver. 40.

In short, our author has endeavoured by many ingenious arguments and illustrations to establish it as a truth in criticism, that the end of poetry is *to please*. Verses, if pleasing, may be poetical, though they convey little or no instruction; but verses, whose sole merit it is that they convey instruction, are not poetical. Instruction, however, he admits, especially in poems of length, is necessary to their *perfection*, because they would not be *perfectly agreeable* without it.

SECT. II. *Of the Standard of Poetical Invention.*

6 Poetical invention to be regulated

HOMER's beautiful description of the heavens and earth, as they appear in a calm evening by the light of the moon and stars, concludes with this circumstance, "And the heart of the shepherd is glad ¶." Madame Dacier, from the turn she gives to the passage in her version, seems to think, and Pope, in order perhaps to make out his couplet, insinuates, that the gladness of the shepherd is owing to his sense of the utility of those luminaries. And this may in part be the case: but this is not in Homer; nor is it a necessary consideration. It is true, that, in contemplating the material universe, they who discern the causes and effects of things must be more rapturously entertained than those who perceive nothing but shape and size, colour and motion. Yet, in the mere outside of Nature's work, there is a splendor and a magnificence to which even untutored minds cannot attend without great delight.

¶ *Iliad*, b. 8. v. 555.

Beattie's *Essays*, Part I. chap. ii.

Not that all peasants or all philosophers are equally susceptible of these charming impressions. It is strange to observe the callousness of some men, before whom all the glories of heaven and earth pass in daily succession, without touching their hearts, elevating their fancy, or leaving any durable remembrance. Even of those who pretend to sensibility, how many are there to whom the lustre of the rising or setting sun; the sparkling concave of the midnight-sky; the mountain-forest tossing and roaring to the storm, or warbling with all the melodies of a summer-evening; the sweet interchange of hill and dale, shade and sunshine, grove, lawn, and water, which an extensive landscape offers to the view; the scenery of the ocean, so lovely, so majestic, and so tremendous; and the many pleasing varieties of the animal and vegetable kingdoms, could never afford so much real satisfaction, as the steams and noise of a ball-room, the insipid fiddling and squeaking of an opera, or the vexations and wranglings of a card-table!

But some minds there are of a different make; who, even in the early part of life, receive from the contemplation of Nature a species of delight which they would hardly exchange for any other, and who, as avarice and ambition are not the infirmities of that period, would, with equal sincerity and rapture, exclaim,

> I care not, Fortune, what you me deny;
> You cannot rob me of free Nature's grace;
> You cannot shut the windows of the sky,
> Through which Aurora shows her bright'ning face;
> You cannot bar my constant feet to trace
> The woods and lawns by living stream at eve.
>
> *Castle of Indolence.*

Such minds have always in them the seeds of true taste, and frequently of imitative genius. At least, though their enthusiastic or visionary turn of mind (as the man of the world would call it) should not always incline them to practise poetry or painting, we need not scruple to affirm, that without some portion of this enthusiasm no person ever became a true poet or painter. For he who would imitate the works of nature, must first accurately observe them; and accurate observation is to be expected from those only who take great pleasure in it.

To a mind thus disposed no part of creation is indifferent. In the crowded city and howling wilderness; in the cultivated province and solitary isle; in the flowery lawn and craggy mountain; in the murmur of the rivulet and in the uproar of the ocean; in the radiance of summer and gloom of winter; in the thunder of heaven and in the whisper of the breeze; he still finds something to rouze or to soothe his imagination, to draw forth his affections, or to employ his understanding. And from every mental energy that is not attended

f
tion.

attended with pain, and even from ſome of thoſe that are, as moderate terror and pity, a ſound mind derives ſatisfaction; exerciſe being equally neceſſary to the body and the ſoul, and to both equally productive of health and pleaſure.

This happy ſenſibility to the beauties of nature ſhould be cheriſhed in young perſons. It engages them to contemplate the Creator in his wonderful works; it purifies and harmonizes the ſoul, and prepares it for moral and intellectual diſcipline; it ſupplies an endleſs ſource of amuſement; it contributes even to bodily health: and, as a ſtrict analogy ſubſiſts between material and moral beauty, it leads the heart by an eaſy tranſition from the one to the other; and thus recommends virtue for its tranſcendant loveline ſs, and makes vice appear the object of contempt and abomination. An intimate acquaintance with the beſt deſcriptive poets, Spenſer, Milton, and Thomſon, but above all with the divine Georgic, joined to ſome practice in the art of drawing, will promote this amiable ſenſibility in early years: for then the face of nature has novelty ſuperadded to its other charms, the paſſions are not pre-engaged, the heart is free from care, and the imagination warm and romantic.

7
he
ard of
e.

But not to inſiſt longer on thoſe ardent emotions that are peculiar to the enthuſiaſtic diſciple of nature, may it not be affirmed of all men, without exception, or at leaſt of all the enlightened part of mankind, that they are gratified by the contemplation of things natural, as oppoſed to unnatural? Monſtrous ſights pleaſe but for a moment, if they pleaſe at all; for they derive their charm from the beholder's amazement, which is quickly over. We read indeed of a man of rank in Sicily *, who chooſes to adorn his villa with pictures and ſtatues of moſt unnatural deformity: but it is a ſingular inſtance; and one would not be much more ſurpriſed to hear of a perſon living without food, or growing fat by the uſe of poiſon. To ſay of any thing, that it is *contrary to nature*, denotes cenſure and diſguſt on the part of the ſpeaker; as the epithet *natural* intimates an agreeable quality, and ſeems for the moſt part to imply, that a thing is as it ought to be, ſuitable to our own taſte, and congenial with our own conſtitution. Think with what ſentiments we ſhould peruſe a poem, in which nature was totally miſrepreſented, and principles of thought, and of operation ſuppoſed to take place, repugnant to every thing we had ſeen or heard of:—in which, for example, avarice and coldneſs were aſcribed to youth, and prodigality and paſſionate attachment to the old; in which men were made to act at random, ſometimes according to character, and ſometimes contrary to it; in which cruelty and envy were productive of love, and beneficence and kind affection of hatred; in which beauty was invariably the object of diſlike, and ugline ſs of deſire; in which ſociety was rendered happy by atheiſm and the promiſcuous perpetration of crimes, and juſtice and fortitude were held in univerſal contempt. Or think, how we ſhould reliſh a painting, where no regard was had to the proportions, colours, or any of the phyſical laws, of Nature:—where the ears and eyes of animals were placed in their ſhoulders; where the ſky was green and the graſs crimſon; where trees grew with their branches in the earth and their roots in the air; where men were ſeen fighting after their heads were cut off, ſhips ſailing on the land, lions entangled in cobwebs, ſheep preying on dead carcaſes, fiſhes ſporting in the woods, and elephants walking on the ſea. Could ſuch figures and combinations give pleaſure, or merit the appellation of ſublime or beautiful? Should we heſitate to pronounce their author mad? And are the abſurdities of madmen proper ſubjects either of amuſement or of imitation to reaſonable beings?

*ydone's
in Si-
et. 24.

Of
Invention.

Let it be remarked, too, that though we diſtinguiſh our internal powers by different names, becauſe otherwiſe we could not ſpeak of them ſo as to be underſtood, they are all but ſo many energies of the ſame individual mind; and therefore it is not to be ſuppoſed, that what contradicts any one leading faculty ſhould yield permanent delight to the reſt. That cannot be agreeable to reaſon, which conſcience diſapproves; nor can that gratify imagination, which is repugnant to reaſon.—Beſides, belief and acquieſcence of mind are pleaſant, as diſtruſt and diſbelief are painful: and therefore, that only can give ſolid and general ſatisfaction, which has ſomething of plauſibility in it; ſomething which we conceive it poſſible for a rational being to believe. But no rational being can acquieſce in what is obviouſly contrary to nature, or implies palpable abſurdity.

Poetry, therefore, and indeed every art whoſe end is to pleaſe, muſt be natural; and if ſo, muſt exhibit real matter of fact, or ſomething like it; that is, in other words, muſt be either according to truth or according to veriſimilitude.

And tho' every part of the material univerſe abounds in objects of pleaſurable contemplation, yet nothing in nature ſo powerfully touches our hearts, or gives ſo great variety of exerciſe to our moral and intellectual faculties, as man. Human affairs and human feelings are univerſally intereſting. There are many who have no great reliſh for the poetry that delineates only irrational or inanimate beings; but to that which exhibits the fortunes, the characters, and the conduct of men, there is hardly any perſon who does not liſten with ſympathy and delight. And hence, to imitate human action, is conſidered by Ariſtotle as eſſential to this art; and muſt be allowed to be eſſential to the moſt pleaſing and moſt inſtructive part of it, Epic and Dramatic compoſition. Mere deſcriptions, however beautiful, and moral reflections, however juſt, become tireſome, where our paſſions are not occaſionally awakened by ſome event that concerns our fellow-men. Do not all readers of taſte receive peculiar pleaſure from thoſe little tales or epiſodes with which Thomſon's deſcriptive poem on the Seaſons is here and there enlivened? and are they not ſenſible, that the thunder-ſtorm would not have been half ſo intereſting without the tale of the two lovers (*Summ.* v. 1171); nor the harveſt-ſcene, without that of Palemon and Lavinia (*Aut.* v. 177.); nor the driving ſnows, without that exquiſite picture of a man periſhing among them (*Winter*, v. 276.)? It is much to be regretted, that Young did not employ the ſame artifice to animate his Night-Thoughts. Sentiments and deſcriptions may be regarded as the pilaſters, carvings, gildings, and other decorations of the poetical fabric: but human actions are the columns and the rafters that give it ſtability and elevation. Or, changing the metaphor, we may conſider theſe as the ſoul which informs the lovely frame; while thoſe are little more than the ornaments of the body.

Whether the pleaſure we take in things natural, and

Of Invention

our diſlike to what is the reverſe, be the effect of habit or of conſtitution, is not a material inquiry. There is nothing abſurd in ſuppoſing, that between the ſoul, in its firſt formation, and the reſt of nature, a mutual harmony and ſympathy may have been eſtabliſhed, which experience may indeed confirm, but no perverſe habits could entirely ſubdue.

8 Habit has great influence over ſentiment and feeling, and of courſe upon poetry.

As no ſort of education could make man believe the contrary of a ſelf-evident axiom, or reconcile him to a life of perfect ſolitude; ſo we ſhould imagine, that our love of nature and regularity might ſtill remain with us in ſome degree, though we had been born and bred in the Sicilian villa abovementioned, and never heard any thing applauded but what deſerved cenſure, nor cenſured but what merited applauſe. Yet habit muſt be allowed to have a powerful influence over the ſentiments and feelings of mankind: for objects to which we have been long accuſtomed, we are apt to contract a fondneſs: we conceive them readily, and contemplate them with pleaſure; nor do we quit our old tracts of ſpeculation or practice without reluctance and pain. Hence in part ariſes our attachment to our own profeſſions, our old acquaintance, our native ſoil, our homes, and to the very hills, ſtreams, and rocks in our neighbourhood. It would therefore be ſtrange, if man, accuſtomed as he is from his earlieſt days to the regularity of nature, did not contract a liking to her productions and principles of operation.

9 No neceſſity that the poet ſhould exactly copy nature.

Yet we neither expect nor deſire, that every human invention, where the end is only to pleaſe, ſhould be an exact tranſcript of real exiſtence. It is enough, that the mind acquieſce in it as probable or plauſible, or ſuch as we think might happen without any direct oppoſition to the laws of nature;—Or, to ſpeak more accurately, it is enough that it be conſiſtent, either, firſt, with general experience; or, ſecondly, with popular opinion; or, thirdly, that it be conſiſtent with itſelf, and connected with probable circumſtances.

Firſt: If a human invention be conſiſtent with *general* experience, we acquieſce in it as ſufficiently probable. *Particular* experiences, however, there may be, ſo uncommon, and ſo little expected, that we ſhould not admit their probability, if we did not know them to be true. No man of ſenſe believes, that he has any likelihood of being enriched by the diſcovery of hidden treaſure; or thinks it probable, on purchaſing a lottery-ticket, that he ſhall gain the firſt prize: and yet great wealth has actually been acquired by ſuch good fortune. But we ſhould look upon theſe as poor expedients in a play or romance for bringing about a happy cataſtrophe. We expect that fiction ſhould be more conſonant to the general tenor of human affairs; in a word, that not poſſibility, but probability, ſhould be the ſtandard of poetical invention.

10 Fiction ſufficiently conformable to nature when it accords with received opinions,

Secondly: Fiction is admitted as conformable to this ſtandard, when it accords with received opinions. Theſe may be erroneous, but are not often *apparently* repugnant to nature. On this account, and becauſe they are familiar to us from our infancy, the mind readily acquieſces in them, or at leaſt yields them that degree of credit which is neceſſary to render them pleaſing: hence the fairies, ghoſts, and witches of Shakeſpeare, are admitted as probable beings; and angels obtain a place in religious pictures though we know that they do not now appear in the ſcenery of real life. A poet who ſhould at this day make the whole action of his tragedy depend upon enchantment, and produce the chief events by the aſſiſtance of ſupernatural agents, would indeed be cenſured as tranſgreſſing the bounds of probability, be baniſhed from the theatre to the nurſery, and condemned to write fairy tales inſtead of tragedies. But Shakeſpeare was in no danger of ſuch cenſures: In his days the doctrine of witchcraft was eſtabliſhed both by law and by the faſhion; and it was not only unpolite, but criminal, to doubt it. Now indeed it is admitted only by the vulgar; but it does not therefore follow that an old poem built upon it ſhould not be acceptable to the learned themſelves. When a popular opinion has long been exploded, and has become repugnant to philoſophical belief, the fictions built upon it are ſtill admitted as natural, both becauſe we all remember to have liſtened to them in childhood with ſome degree of credit, and becauſe we know that they were accounted natural by the people to whom they were firſt addreſſed; whoſe ſentiments and views of things we are willing to adopt, when, by the power of pleaſing deſcription, we are introduced into their ſcenes, and made acquainted with their manners. Hence we admit the theology of the ancient poets, their Elyſium and Tartarus, Scylla and Charybdis, Cyclops and Circe, and the reſt of thoſe "beautiful wonders" (as Horace calls them), which were believed in the heroic ages; as well as the demons and enchantments of Taſſo, which may be ſuppoſed to have obtained no ſmall degree of credit among the Italians of the 16th century, and are ſuitable enough to the notions that prevailed univerſally in Europe not long before (A). In fact, when poetry is in other reſpects true, when it gives an accurate diſplay of thoſe parts of nature about which we know that men in all ages muſt have entertained the ſame opinion, namely, thoſe appearances in the viſible creation, and thoſe feelings and workings of the human mind, which are obvious to all mankind;—when poetry is thus far according to nature, we are very willing to be indulgent to what is fictitious in it, and to grant a temporary allowance to any ſyſtem of fable which the author pleaſes to adopt; provided that he lay the ſcene in a diſtant country, or fix the date to a remote period. This is no unreaſonable piece of complaiſance; we owe it both to the poet and to ourſelves; for without it we ſhould neither form a right eſtimate of his genius, nor receive from his works that pleaſure which they were intended to impart. Let him, however, take care, that his ſyſtem of fable be ſuch as his countrymen and cotemporaries (to whom his work is immediately addreſſed) might be ſuppoſed capable of yielding their aſſent to; for otherwiſe we ſhould not believe him to be in earneſt: and let him connect it as much

(A) In the 14th century, the common people of Italy believed, that the poet Dante went down to hell; that the *Inferno* was a true account of what he ſaw there; and that his ſallow complexion, and ſtunted beard (which ſeemed by its growth and colour to have been too near the fire), were the conſequence of his paſſing ſo much of his time in that hot and ſmoky region. See *Vicende della Literatura del Sig. C. Denina*, cap. 4.

much as he can with probable circumſtances, and make it appear in a ſeries of events conſiſtent with itſelf.

For (thirdly) if this be the caſe, we ſhall admit his ſtory as probable, or at leaſt as natural, and conſequently be intereſted in it, even though it be not warranted by general experience, and derive but ſlender authority from popular opinion. Calyban, in the Tempeſt, would have ſhocked the mind as an improbability, if we had not been made acquainted with his origin, and ſeen his character diſplayed in a ſeries of conſiſtent behaviour. But when we are told that he ſprung from a witch and a demon, a connection not contrary to the laws of nature, as they were underſtood in Shakeſpeare's time, and find his manners conformable to his deſcent, we are eaſily reconciled to the fiction. In the ſame ſenſe, the Lilliputians of Swift may paſs for probable beings; not ſo much becauſe we know that a belief in pigmies was once current in the world (for the true ancient pigmy was at leaſt thrice as tall as thoſe whom Gulliver viſited), but becauſe we find that every circumſtance relating to them accords with itſelf, and with their ſuppoſed character. It is not the ſize of the people only that is diminutive; their country, ſeas, ſhips, and towns, are all in exact proportion; their theological and political principles, their paſſions, manners, cuſtoms, and all the parts of their conduct, betray a levity and littleneſs perfectly ſuitable; and ſo ſimple is the whole narration, and apparently ſo artleſs and ſincere, that we ſhould not much wonder if it had impoſed (as we have been told it has) upon ſome perſons of no contemptible underſtanding. The ſame degree of credit may perhaps for the ſame reaſons be due to his giants. But when he grounds his narrative upon a contradiction to nature; when he preſents us with rational brutes, and irrational men; when he tells us of horſes building houſes for habitation, milking cows for food, riding in carriages, and holding converſations on the laws and politics of Europe; not all his genius (and he there exerts it to the utmoſt) is able to reconcile us to ſo monſtrous a fiction: we may ſmile at ſome of his abſurd exaggerations; we may be pleaſed with the energy of ſtyle, and accuracy of deſcription, in particular places; and a malevolent heart may triumph in the ſatire; but we can never reliſh it as a fable, becauſe it is at once unnatural and ſelf-contradictory. Swift's judgment ſeems to have forſaken him on this occaſion: he wallows in naſtineſs and brutality: and the general run of his ſatire is downright defamation. Lucian's *True Hiſtory* is a heap of extravagancies put together without order or unity, or any other apparent deſign than to ridicule the language and manner of grave authors. His ravings, which have no better right to the name of *fable*, than a hill of rubbiſh has to that of palace, are deſtitute of every colour of plauſibility. Animal trees, ſhips ſailing in the ſky, armies of monſtrous things travelling between the ſun and moon on a pavement of cobwebs, rival nations of men inhabiting woods and mountains in a whale's belly,—are liker the dreams of a bedlamite than the inventions of a rational being.

If we were to proſecute this ſubject any farther, it would be proper to remark, that in ſome kinds of poetical invention a ſtricter probability is required than in others:—that, for inſtance, Comedy, whether dramatic or narrative (B), muſt ſeldom deviate from the ordinary courſe of human affairs, becauſe it exhibits the manners of real and even of familiar life:—that the tragic poet, becauſe he imitates characters more exalted, and generally refers to events little known, or long ſince paſt, may be allowed a wider range; but muſt never attempt the marvellous fictions of the epic muſe, becauſe he addreſſes his work, not only to the paſſions and imagination of mankind, but alſo to their eyes and ears, which are not eaſily impoſed on, and refuſe to be gratified with any repreſentation that does not come very near the truth:—that the epic poem may claim ſtill ampler privileges, becauſe its fictions are not ſubject to the ſcrutiny of any outward ſenſe, and becauſe it conveys information in regard both to the higheſt human characters, and the moſt important and wonderful events, and alſo to the affairs of unſeen worlds and ſuperior beings. Nor would it be improper to obſerve, that the ſeveral ſpecies of comic, of tragic, of epic compoſition, are not confined to the ſame degree of probability: for that farce may be allowed to be leſs probable than the regular comedy; the maſque than the regular tragedy; and the mixed epic, ſuch as the Fairy Queen, and Orlando Furioſo, than the pure epopee of Homer, Virgil, and Milton. But this part of the ſubject ſeems not to require further illuſtration. Enough has been ſaid to ſhow, that nothing unnatural can pleaſe; and that therefore poetry, whoſe end is to pleaſe, muſt be *according to nature*.

Of Nature in Poetry.

And if ſo, it muſt be either according to real nature, or according to nature ſomewhat different from the reality.

Sect. III. *Of the Syſtem of Nature exhibited by Poetry.*

To exhibit *real nature* is the buſineſs of the hiſtorian; who, if he were ſtrictly to confine himſelf to his own ſphere, would never record even the minuteſt circumſtance of any ſpeech, event, or deſcription, which was 13
not warranted by ſufficient authority. It has been the language of critics in every age, that the hiſtorian ought to relate nothing as true which is falſe or dubious, and to conceal nothing material which he knows to be true. But it is to be doubted whether any writer of profane hiſtory has ever been ſo ſcrupulous. Thucydides himſelf, who began his hiſtory when that war began which he records, and who ſet down every event ſoon after it happened, according to the moſt authentic information, ſeems, however, to have indulged his fancy not a little in his harangues and deſcriptions, particularly that of the plague of Athens: and the ſame thing has been practiſed, with greater latitude, by Livy and Tacitus, and more or leſs by all the beſt hiſtorians both ancient and modern. Nor are they to be blamed for it. By theſe improved or invented ſpeeches, and by the heightenings thus given to their deſcriptions, their work becomes more intereſting, and more uſeful; nobody is deceived,

Hiſtorians embelliſh their works by fiction, and make them

(B) Fielding's *Tom Jones*, *Amelia*, and *Joſeph Andrews*, are examples of what may be called the *Epic* or *Narrative Comedy*, or more properly perhaps the *Comic Epopee*.

Of Nature in Poetry.

ceived, and hiſtorical truth is not materially affected. A medium is, however, to be obſerved in this, as in other things. When the hiſtorian lengthens a deſcription into a detail of fictitious events, as Voltaire has done in his account of the battle of Fontenoy, he loſes his credit with us, by raiſing a ſuſpicion that he is more intent upon a pretty ſtory than upon the truth. And we are diſguſted with his inſincerity, when, in defiance even of veriſimilitude, he puts long elaborate orations in the mouth of thoſe, of whom we know, either from the circumſtances that they could not, or from more authentic records that they did not, make any ſuch orations; as Dionyſius of Halicarnaſſus has done in the caſe of Volumnia haranguing her ſon Coriolanus, and Flavius Joſephus in that of Judah addreſſing his brother as viceroy of Egypt. From what theſe hiſtorians relate, one would conjecture that the Roman matron had ſtudied at Athens under ſome long-winded rhetorician, and that the Jewiſh patriarch muſt have been one of the moſt flowery orators of antiquity. But the fictitious part of hiſtory, or of ſtory-telling, ought never to take up much room; and muſt be highly blameable when it leads into any miſtake either of facts or of characters.

Now, why do hiſtorians take the liberty to embelliſh their works in this manner? One reaſon, no doubt, is, that they may diſplay their talents in oratory and narration: but the chief reaſon, as hinted already, is, to ren-

14
In ſome degree poetical.

der their compoſition more agreeable. It would ſeem, then, that ſomething more pleaſing than real nature, or ſomething which ſhall add to the pleaſing qualities of real nature, may be deviſed by human fancy. And this may certainly be done. And this it is the poet's buſineſs to do. And when this is in any degree done by the hiſtorian, his narrative becomes in that degree poetical.

Beattie's Eſſays, chap. ii.

The poſſibility of thus improving upon nature muſt be obvious to every one. When we look at a landſcape, we can fancy a thouſand additional embelliſhments. Mountains loftier and more pictureſque; rivers more copious, more limpid, and more beautifully winding; ſmoother and wider lawns; valleys more richly diverſified; caverns and rocks more gloomy and more ſtupendous; ruins more majeſtic; buildings more magnificent; oceans more varied with iſlands, more ſplendid with ſhipping, or more agitated by ſtorm, than any we have ever ſeen—it is eaſy for human imagination to conceive. Many things in art and nature exceed expectation; but nothing ſenſible tranſcends or equals the capacity of thought:—a ſtriking evidence of the dignity of the human ſoul! The fineſt woman in the world appears to every eye ſuſceptible of improvement, except perhaps to that of her lover. No wonder, then, if in

15
Poets embelliſh nature itſelf,

poetry events can be exhibited more compact, and of more pleaſing variety, than thoſe delineated by the hiſtorian, and ſcenes of inanimate nature more dreadful or more lovely, and human characters more ſublime and more exquiſite, both in good and evil. Yet ſtill let nature ſupply the ground-work and materials, as well as the ſtandard, of poetical fiction. The moſt expert painters uſe a layman, or other viſible figure, to direct their hand and regulate their fancy. Homer himſelf founds his two poems on authentic tradition; and tragic as well as epic poets have followed the example. The writers of romance, too, are ambitious to interweave true adventures with their fables; and when it can be conveniently done, to take the outlines of their plan from real life. Thus the tale of Robinſon Cruſoe is founded on an incident that actually befel one Alexander Selkirk, a ſea-faring man, who lived ſeveral years alone in the iſland of Juan Fernandes: Smollet is thought to have given us ſeveral of his own adventures in the hiſtory of Roderic Random: and the chief characters in Tom Jones, Joſeph Andrews, and Pamela, are ſaid to have been copied from real originals. Dramatic comedy, indeed, is for the moſt part purely fictitious: for if it were to exhibit real events as well as preſent manners, it would become too perſonal to be endured by a well-bred audience, and degenerate into downright abuſe; which appears to have been the caſe with the old comedy of the Greeks *. But in general, hints taken from real exiſtence will be found to give no little grace and ſtability to fiction, even in the moſt fanciful poems. Thoſe hints, however, may be improved by the poet's imagination, and ſet off with every probable ornament that can be deviſed, conſiſtently with the deſign and genius of the work; or, in other words, with the ſympathies that the poet means to awaken in the mind of his reader. For mere poetical ornament, when it fails to intereſt the affections, is not only uſeleſs, but improper; all true poetry being addreſſed to the heart, and intended to give pleaſure by raiſing or ſoothing the paſſions;—the only effectual way of pleaſing a rational and moral creature. And therefore we would take Horace's maxim to be univerſal in poetry: "*Non ſatis eſt, pulchra eſſe poemata; dulcia ſunto:*" "It is not enough that poems be beautiful; let them alſo be *affecting:*"—For that this is the meaning of the word *dulcia* in this place, is admitted by the beſt interpreters, and is indeed evident from the context †.

That the ſentiments and feelings of percipient beings, when expreſſed in poetry, ſhould call forth our affections, is natural enough; but can deſcriptions of inanimate things alſo be made affecting? certainly they can: and the more they affect, the more they pleaſe us, and the more poetical we allow them to be. Virgil's Georgic is a noble ſpecimen (and indeed the nobleſt in the world) of this ſort of poetry. His admiration of external nature gains upon a reader of taſte, till it riſe to perfect enthuſiaſm. The following obſervations will perhaps explain this matter.

Every thing in nature is complex in itſelf, and bears innumerable relations to other things; and may therefore be viewed in an endleſs variety of lights, and conſequently deſcribed in an endleſs variety of ways. Some deſcriptions are good, and others bad. An hiſtorical deſcription, that enumerates all the qualities of any object, is certainly good, becauſe it is true; but may be as unaffecting as a logical definition. In poetry, no unaffecting deſcription is good, however conformable to truth: for here we expect not a complete enumeration of qualities (the chief end of the art being to pleaſe), but only ſuch an enumeration as may give a lively and intereſting idea. It is not memory, or the knowledge of rules, that can qualify a poet for this ſort of deſcription; but a peculiar livelineſs of fancy and ſenſibility of heart, the nature whereof we may explain by its effects, but we cannot lay down rules for the attainment of it.

When our mind is occupied by any emotion, we naturally uſe words and meditate on things that are ſuitable

able to it and tend to encourage it. If a man were to write a letter when he is very angry, there would probably be ſomething of vehemence or bitterneſs in the ſtyle, even though the perſon to whom he wrote were not the object of his anger. The ſame thing holds true of every other ſtrong paſſion or emotion:—while it predominates in the mind, it gives a peculiarity to our thoughts, as well as to our voice, geſture, and countenance: And hence we expect, that every perſonage introduced in poetry ſhould ſee things through the medium of his ruling paſſion, and that his thoughts and language ſhould be tinctured accordingly. A melancholy man walking in a grove, attends to thoſe things that ſuit and encourage his melancholy; the ſighing of the wind in the trees, the murmuring of waters, the darkneſs and ſolitude of the ſhades: A cheerful man in the ſame place, finds many ſubjects of cheerful meditation, in the ſinging of birds, the briſk motions of the babbling ſtream, and the liveliness and variety of the verdure. Perſons of different characters, contemplating the ſame thing, a Roman triumph, for inſtance, feel different emotions, and turn their view to different objects. One is filled with wonder at ſuch a diſplay of wealth and power; another exults in the idea of conqueſt, and pants for military renown; a third, ſtunned with clamour, and haraſſed with confuſion, wiſhes for ſilence, ſecurity, and ſolitude; one melts with pity to the vanquiſhed, and makes many a ſad reflection upon the inſignificance of worldly grandeur, and the uncertainty of human things; while the buffoon, and perhaps the philoſopher, conſiders the whole as a vain piece of pageantry, which, by its ſolemn procedure, and by the admiration of ſo many people, is only rendered the more ridiculous:—and each of theſe perſons would deſcribe it in a way ſuitable to his own feelings, and tending to raiſe the ſame in others. We ſee in Milton's Allegro and Penſoroſo, how a different caſt of mind produces a variety in the manner of conceiving and contemplating the ſame rural ſcenery. In the former of theſe excellent poems, the author perſonates a cheerful man, and takes notice of thoſe things in external nature that are ſuitable to cheerful thoughts, and tend to encourage them: in the latter, every object deſcribed is ſerious and ſolemn, and productive of calm reflection and tender melancholy: and we ſhould not be eaſily perſuaded, that Milton wrote the firſt under the influence of ſorrow, or the ſecond under that of gladneſs. We often ſee an author's character in his works; and if every author were in earneſt when he writes, we ſhould oftener ſee it. Thomſon was a man of piety and benevolence, and a warm admirer of the beauties of nature; and every deſcription in his delightful poem on the Seaſons tends to raiſe the ſame laudable affections in his reader. The parts of nature that attract his notice are thoſe which an impious or hard-hearted man would neither attend to, nor be affected with, at leaſt in the ſame manner. In Swift we ſee a turn of mind very different from that of the amiable Thomſon; little reliſh for the ſublime or beautiful, and a perpetual ſucceſſion of violent emotions. All his pictures of human life ſeem to ſhow, that deformity and meanneſs were the favourite objects of his attention, and that his ſoul was a conſtant prey to indignation (c), diſguſt, and other gloomy paſſions, ariſing from ſuch a view of things. And it is the tendency of almoſt all his writings (though it was not always the author's deſign), to communicate the ſame paſſions to his reader: inſomuch, that notwithſtanding his erudition and knowledge of the world, his abilities as a popular orator and man of buſineſs, the energy of his ſtyle, the elegance of ſome of his verſes, and his extraordinary talents in wit and humour, there is reaſon to doubt, whether by ſtudying his works any perſon was ever much improved in piety or benevolence.

Of Nature in Poetry.

18

It is thus that poetry affects the heart whatever be its ſubject.

And thus we ſee, how the compoſitions of an ingenious author may operate upon the heart, whatever be the ſubject. The affections that prevail in the author himſelf, direct his attention to objects congenial, and give a peculiar bias to his inventive powers, and a peculiar colour to his language. Hence his work, as well as face, if nature is permitted to exert herſelf freely in it, will exhibit a picture of his mind, and awaken correſpondent ſympathies in the reader. When theſe are favourable to virtue, which they always ought to be, the work will have that ſweet pathos to which Horace alludes in the paſſage above mentioned; and which we ſo highly admire, and ſo warmly approve, even in thoſe parts of the Georgic that deſcribe inanimate nature.

Horace's account of the matter in queſtion differs not from what is here given. "It is not enough (ſays he*) that poems be beautiful; let them be affecting, and agitate the mind with whatever paſſions the poet wiſhes to impart. The human countenance, as it ſmiles on thoſe who ſmile, accompanies alſo with ſympathetic tears thoſe who mourn. If you would have me weep, you muſt firſt weep yourſelf; then, and not before, ſhall I be touched with your misfortunes.—For nature firſt makes the emotions of our mind correſpond with our circumſtances, infuſing real joy, ſorrow, or reſentment, according to the occaſion; and afterwards gives the true pathetic utterance to the voice and language." This doctrine, which concerns the orator and the player no leſs than the poet, is ſtrictly philoſophical, and equally applicable to dramatic, to deſcriptive, and indeed to every ſpecies of intereſting poetry. The poet's ſenſibility muſt firſt of all engage him warmly in his ſubject, and in every part of it; otherwiſe he will labour in vain to intereſt the reader. If he would paint external nature, as Virgil and Thomſon have done, ſo as to make her amiable to others, he muſt firſt be enamoured of her himſelf; if he would have his heroes and heroines ſpeak the language of love or ſorrow, devotion or courage, ambition or anger, benevolence or pity, his heart muſt be ſuſceptible of thoſe emotions, and in ſome degree feel them, as long at leaſt as he employs himſelf in framing words for them; being aſſured, that

* *Ar. Poet.* v. 99—111.

He beſt ſhall paint them who can feel them moſt.

Pope's *Eloiſa*, v. 366.

The

(c) For part of this remark we have his own authority, often in his letters, and very explicitly in the Latin epitaph which he compoſed for himſelf:—"ubi ſæva indignatio ulterius cor lacerare nequit." *See his laſt will and teſtament.*

Of Nature in Poetry.

19 The true poet must possess fancy to invent decorations to nature.

The true poet, therefore, must not only study nature, and know the reality of things, but must also possess fancy, to invent additional decorations; judgment, to direct him in the choice of such as accord with verisimilitude; and sensibility, to enter with ardent emotions into every part of his subject, so as to transfuse into every part of his work a pathos and energy sufficient to raise corresponding emotions in the reader.

* Poetic. sect. 9.

"The historian and the poet (says Aristotle *) differ in this, that the former exhibits things as they are, the latter as they might be;"—*i. e.* in that state of perfection which is consistent with probability, and in which, for the sake of our own gratification, we wish to find them. If the poet, after all the liberties he is allowed to take with the truth, can produce nothing more exquisite than is commonly to be met with in history, his reader will be disappointed and dissatisfied. Poetical representations must therefore be framed after a pattern of the highest probable perfection that the genius of the work will admit:—external nature must in them be more picturesque than in reality; action more animated; sentiments more expressive of the feelings and character, and more suitable to the circumstances of the speaker; personages better accomplished in those qualities that raise admiration, pity, terror, and other ardent emotions; and events more compact, more clearly connected with causes and consequences, and unfolded in an order more flattering to the fancy, and more interesting to the passions. But where, it may be said, is this pattern of perfection to be found? Not in real nature; otherwise history, which delineates real nature, would also delineate this pattern of perfection. It is to be found only in the mind of the poet; and it is imagination, regulated by knowledge, that enables him to form it.

In the beginning of life, and while experience is confined to a small circle, we admire every thing, and are pleased with very moderate excellence. A peasant thinks the hall of his landlord the finest apartment in the universe, listens with rapture to the strolling ballad-singer, and wonders at the rude wooden cuts that adorn his ruder compositions. A child looks upon his native village as a town; upon the brook that runs by as a river; and upon the meadows and hills in the neighbourhood as the most spacious and beautiful that can be. But when, after long absence, he returns in his declining years, to visit, once before he die, the dear spot that gave him birth, and those scenes whereof he remembers rather the original charms than the exact proportions; how is he disappointed to find every thing so debased and so diminished! The hills seem to have sunk into the ground, the brook to be dried up, and the village to be forsaken of its people; the parish-church, stripped of all its fancied magnificence, is become low, gloomy, and narrow; and the fields are now only the miniature of what they were. Had he never left this spot, his notions might have remained the same as at first; and had he travelled but a little way from it, they would not perhaps have received any material enlargement. It seems then to be from observation of many things of the same or similar kinds, that we acquire the talent of forming ideas more perfect than the real objects that lie immediately around us: and these ideas we may improve gradually more and more, according to the vivacity of our mind, and extent of our experience, till at last we come to raise them to a degree of perfection superior to any thing to be found in real life. There cannot sure be any mystery in this doctrine; for we think and speak to the same purpose every day. Thus nothing is more common than to say, that such an artist excels all we have ever known in his profession, and yet that we can still conceive a superior performance. A moralist, by bringing together into one view the separate virtues of many persons, is enabled to lay down a system of duty more perfect than any he has ever seen exemplified in human conduct. Whatever be the emotion the poet intends to raise in his reader, whether admiration or terror, joy or sorrow; and whatever be the object he would exhibit, whether Venus or Tisiphone, Achilles or Thersites, a palace or a pile of ruins, a dance or a battle; he generally copies an idea of his own imagination; considering each quality as it is found to exist in several individuals of a species, and thence forming an assemblage more or less perfect in its kind, according to the purpose to which he means to apply it.

20 Observation of many things of the same kind a great help to poetical fancy, because

21 Poetical conceptions must be general

Hence it would appear, that the ideas of poetry are rather general than singular; rather collected from the examination of a species or class of things, than copied from an individual. And this, according to Aristotle, is in fact the case, at least for the most part; whence that critic determines, that poetry is something more exquisite and more philosophical than history *. The historian may describe Bucephalus, but the poet delineates a war-horse; the former must have seen the animal he speaks of, or received authentic information concerning it, if he mean to describe it historically; for the latter, it is enough that he has seen several animals of that sort. The former tells us, what Achilles actually did and said; the latter, what such a species of human character as that which bears the name of Achilles would probably do or say in certain given circumstances.

* Poet. § 9.

It is inded true, that the poet may, and often does, copy after individual objects. Homer, no doubt, took his characters from the life; or at least, in forming them, was careful to follow tradition as far as the nature of his plan would allow. But he probably took the freedom to add or heighten some qualities, and take away others; to make Achilles, for example, stronger, perhaps, and more impetuous, and more eminent for filial affection, and Hector more patriotic and more amiable than he really was. If he had not done this, or something like it, his work would have been rather a history than a poem; would have exhibited men and things as they were, and not as they might have been; and *Achilles* and *Hector* would have been the names of individual and real heroes; whereas, according to Aristotle, they are rather to be considered as two distinct modifications or species of the heroic character. Shakespeare's account of the cliffs of Dover comes so near the truth, that we cannot doubt of its having been written by one who had seen them: but he who takes it for an exact historical description, will be surprised when he comes to the place, and finds those cliffs not half so lofty as the poet had made him believe. An historian would be to blame for such amplification; because, being to describe an individual precipice, he ought to tell us just what it is; which if he did, the description would suit that place, and perhaps no other

in

in the whole world. But the poet means only to give an idea of what fuch a precipice may be; and therefore his defcription may perhaps be equally applicable to many fuch chalky precipices on the fea-fhore.

This method of copying after general ideas formed by the artift from obfervation of many individuals, diftinguifhes the Italian and all the fublime painters, from the Dutch and their imitators. Thefe give us bare nature, with the imperfections and peculiarities of individual things or perfons; but thofe give nature improved as far as probability and the defign of the piece will admit. Teniers and Hogarth draw faces, and figures, and dreffes, from real life, and prefent manners; and therefore their pieces muft in fome degree lofe the effect, and become aukward, when the prefent fafhions become obfolete.——Raphael and Reynolds take their models from general nature; avoiding, as far as poffible, (at leaft in all their great performances), thofe peculiarities that derive their beauty from mere fafhion; and therefore their works muft give pleafure, and appear elegant, as long as men are capable of forming general ideas, and of judging from them. The laft-mentioned incomparable artift is particularly obfervant of children, whofe looks and attitudes, being lefs under the controul of art and local manners, are more characteriftical of the fpecies than thofe of men and women. This field of obfervation has fupplied him with many fine figures, particularly that moft exquifite one of Comedy, ftruggling for and winning (for who could refift her!) the affections of Garrick:—a figure which could never have occurred to the imagination of a painter who had confined his views to grown perfons looking and moving in all the formality of polite life;—a figure which in all ages and countries would be pronounced natural and engaging;—whereas thofe human forms that we fee every day bowing and courtefying, and ftrutting, and turning out their toes *fecundum artem*, and dreffed in ruffles, and wigs, and flounces, and hoop-petticoats, and full-trimmed fuits, would appear elegant no further than the prefent fafhions are propagated, and no longer than they remain unaltered.

13 There is, in the progrefs of human fociety, as well as of human life, a period to which it is of great importance for the higher order of poets to attend, and from which they will do well to take their characters, and manners, and the era of their events; namely, that wherein men are raifed above favage life, and confiderably improved by arts, government, and converfation; but not advanced fo high in the afcent towards politenefs, as to have acquired a habit of difguifing their thoughts and paffions, and of reducing their behaviour to the uniformity of the mode. Such was the period which Homer had the good fortune (as a poet) to live in, and to celebrate. This is the period at which the manners of men are moft picturefque, and their adventures moft romantic. This is the period when the appetites unperverted by luxury, the powers unenervated by effeminacy, and the thoughts difengaged from artificial reftraint, will, in perfons of fimilar difpofitions and circumftances, operate in nearly the fame way; and when, confequently, the characters of particular men will approach to the nature of poetical or general ideas, and, if well imitated, give pleafure to the whole, or at leaft to a great majority of mankind.

But a character tinctured with the fafhions of polite life would not be fo generally interefting. Like a human figure adjufted by a modern dancing-mafter, and dreffed by a modern tailor, it may have a good effect in fatire, comedy, or farce: but if introduced into the higher poetry, it would be admired by thofe only who had learned to admire nothing but prefent fafhions, and by them no longer than the prefent fafhions lafted; and to all the reft of the world would appear aukward, unaffecting, and perhaps ridiculous. But Achilles and Sarpedon, Diomede and Hector, Neftor and Ulyffes, as drawn by Homer, muft in all ages, independently on fafhion, command the attention and admiration of mankind. Thefe have the qualities that are univerfally known to belong to human nature; whereas the modern fine gentleman is diftinguifhed by qualities that belong only to a particular age, fociety, and corner of the world. We fpeak not of moral or intellectual virtues, which are objects of admiration to every age; but of thofe outward accomplifhments, and that particular temperature of the paffions, which form the moft perceptible part of a human character.—As, therefore, the politician, in difcuffing the rights of mankind, muft often allude to an imaginary ftate of nature; fo the poet who intends to raife admiration, pity, terror, and other important emotions, in the generality of mankind, efpecially in thofe readers whofe minds are moft improved, muft take his pictures of life and manners, rather from the heroic period we now fpeak of, than from the ages of refinement; and muft therefore (to repeat the maxim of Ariftotle) "exhibit things, not as they are, but as they might be."

Sect. IV. *Of Poetical Characters.*

Horace feems to think, that a competent knowledge of moral philofophy will fit an author for affigning the fuitable qualities and duties to each poetical perfonage: (*Art. Poet.* v. 309.—316.) The maxim may be true, as far as mere morality is the aim of the poet; but cannot be underftood to refer to the delineation of poetical characters in general: for a thorough acquaintance with all the moral philofophy in the world would not have enabled Blackmore to paint fuch a perfonage as Homer's Achilles, Shakefpeare's Othello, or the Satan of Paradife Loft. To a competency of moral fcience, there muft be added an extenfive knowledge of mankind, a warm and elevated imagination, and the greateft fenfibility of heart, before a genius can be formed equal to fo difficult a tafk. Horace is indeed fo fenfible of the danger of introducing a new character in poetry, that he even difcourages the attempt, and advifes the poet rather to take his perfons from the ancient authors, or from tradition: *Ibid.* v. 119.—130.

To conceive the idea of a good man, and to invent and fupport a great poetical character, are two very different things, however they may feem to have been confounded by fome late critics. The firft is eafy to any perfon fufficiently inftructed in the duties of life: the laft is perhaps of all the efforts of human genius the moft difficult; fo very difficult, that, though attempted by many, Homer, Shakefpeare, and Milton, are almoft the only authors who have fucceeded in it. But characters of perfect virtue are not the moft pro-

Margin notes: [left, cut off] ...f ...e in ...try. — 12 ...der to ...e all and ...tries. — 13 ...period ...he pro- ...of hu- ...fociety which ...and ...ic poets ...ld at- ...d. — [right] Of Poetical Characters. — 11 Requifites to the delineation of poetical characters.

 per

Of Poetical Characters.

per for poetry. It seems to be agreed, that the Deity should not be introduced in the machinery of a poetical fable. To ascribe to him words and actions of our own invention, seems very unbecoming; nor can a poetical description, that is known to be, and must of necessity be, infinitely inadequate, ever satisfy the human mind. Poetry, according to the best critics, is an imitation of human action; and therefore poetical characters, though elevated, should still partake of the passions and frailties of humanity. If it were not for the vices of some principal personages, the Iliad would not be either so interesting or so moral:—the most moving and most eventful parts of the Æneid are those that describe the effects of unlawful passion:—the most instructive tragedy in the world, we mean Macbeth, is founded in crimes of dreadful enormity:—and if Milton had not taken into his plan the fall of our first parents, as well as their state of innocence, his divine poem must have wanted much of its pathos, and could not have been (what it now is) such a treasure of important knowledge, as no other uninspired writer ever comprehended in so small a compass.——Virtue, like truth, is uniform and unchangeable. We may anticipate the part a good man will act in any given circumstances: and therefore the events that depend on such a man must be less surprising than those which proceed from passion; the vicissitudes whereof it is frequently impossible to foresee. From the violent temper of Achilles, in the Iliad, spring many great incidents; which could not have taken place, if he had been calm and prudent like Ulysses, or pious and patriotic like Eneas:—his rejection of Agamemnon's offers, in the ninth book, arises from the violence of his resentment;—his yielding to the request of Patroclus, in the 16th, from the violence of his friendship (if we may so speak) counteracting his resentment; and his restoring to Priam the dead body of Hector, in the 24th, from the violence of his affection to his own aged father, and his regard to the command of Jupiter, counteracting, in some measure, both his sorrow for his friend, and his thirst for vengeance.——Besides, except where there is some degree of vice, it pains us too exquisitely to see misfortune; and therefore poetry would cease to have a pleasurable influence over our tender passions, if it were to exhibit virtuous characters only. And as in life, evil is necessary to our moral probation, and the possibility of error to our intellectual improvement; so bad or mixed characters are useful in poetry, to give to the good such opposition, as puts them upon displaying and exercising their virtue.

25
Which, though elevated, should partake of the frailties of humanity;

26
Whilst the personages in whose fate the poet means that we should be interested ought to have good and great qualities.

All those personages, however, in whose fortune the poet means that we should be interested, must have agreeable and admirable qualities to recommend them to our regard. And perhaps the greatest difficulty in the art lies in suitably blending those faults which the poet finds it expedient to give to any particular hero, with such moral, intellectual, or coporeal accomplishments, as may engage our esteem, pity, or admiration, without weakening our hatred of vice, or love of virtue. In most of our novels, and in many of our plays, it happens unluckily, that the hero of the piece is so captivating, as to incline us to be indulgent to every part of his character, the bad as well as the good. But a great master knows how to give the proper direction to human sensibility; and, without any perversion of our faculties, or any confusion of right and wrong, to make the same person the object of very different emotions, of pity and hatred, of admiration and horror. Who does not esteem and admire Macbeth for his courage and generosity? who does not pity him when beset with all the terrors of a pregnant imagination, superstitious temper, and awakened conscience? who does not abhor him as a monster of cruelty, treachery, and ingratitude? His good qualities, by drawing us near to him, make us, as it were, eye-witnesses of his crime, and give us a fellow-feeling of his remorse; and therefore, his example cannot fail to have a powerful effect in cherishing our love of virtue, and fortifying our minds against criminal impressions: whereas, had he wanted those good qualities, we should have kept aloof from his concerns, or viewed them with a superficial attention; in which case his example would have had little more weight than that of the robber, of whom we know nothing, but that he was tried, condemned, and executed.—Satan, in Paradise Lost, is a character drawn and supported with the most consummate judgment. The old furies and demons, Hecate, Tisiphone, Alecto, Megara, are objects of unmixed and unmitigated abhorrence; Tityus, Enceladus, and their brethren, are remarkable for nothing but impiety, deformity, and vastness of size; Pluto is, at best, an insipid personage; Mars, a hair-brained ruffian; Tasso's infernal tyrant, an ugly and overgrown monster:—but in the Miltonic Satan, we are forced to admire the majesty of the ruined archangel, at the same time that we detest the unconquerable depravity of the fiend. "But, of all poetical characters, (says the elegant critic from whom we are extracting), the Achilles of Homer (D) seems to me the most exquisite of invention, and the most highly finished. The utility of this character in a moral view is obvious; for it may be considered as the source of all the morality of the Iliad. Had not the generous and violent temper of Achilles determined him to patronise the augur Calchas in defiance of Agamemnon, and afterwards, on being affronted by that vindictive commander, to abandon for a time the common cause of Greece;—the fatal effects of dissension among confederates, and of capricious and tyrannical behaviour in a sovereign, would not have been the leading moral of Homer's

Beattie's Essays.

(D) "I say the *Achilles of Homer*. Latter authors have degraded the character of this hero, by supposing every part of his body invulnerable except the heel. I know not how often I have heard this urged as one of Homer's absurdities; and indeed the whole Iliad is one continued absurdity, on this supposition. But Homer all along makes his hero equally liable to wounds and death with other men. Nay, to prevent all mistakes in regard to this matter, (if those who cavil at the poet would but read his work), he actually wounds him in the right arm by the lance of Asteropæus, in the battle near the river Scamander." See *Iliad*, xxi. ver. 161.—168.

etical Characters. Homer's poetry; nor could Hector, Sarpedon, Eneas, Ulyſſes, and the other amiable heroes, have been brought forward to ſignalize their virtues, and to recommend themſelves to the eſteem and imitation of mankind.

7 xcel- f the al ter hilles. "They who form their judgment of Achilles from the imperfect ſketch given of him by Horace in the *Art of Poetry*, (v. 121, 122.); and conſider him only as a hateful compoſition of anger, revenge, fierceneſs, obſtinacy, and pride, can never enter into the views of Homer, nor be ſuitably affected with his narration. All theſe vices are no doubt, in ſome degree, combined in Achilles; but they are tempered with qualities of a different ſort, which render him a moſt intereſting character, and of courſe make the Iliad a moſt intereſting poem. Every reader abhors the faults of this hero: and yet, to an attentive reader of Homer, this hero muſt be the object of eſteem, admiration, and pity; for he has many good as well as bad affections, and is equally violent in all: Nor is he poſſeſſed of a ſingle vice or virtue, which the wonderful art of the poet has not made ſubſervient to the deſign of the poem, and to the progreſs and cataſtrophe of the action; ſo that the hero of the Iliad, conſidered as a poetical perſonage, is juſt what he ſhould be, neither greater nor leſs, neither worſe nor better.—He is everywhere diſtinguiſhed by an abhorrence of oppreſſion, by a liberal and elevated mind, by a paſſion for glory, and by a love of truth, freedom, and ſincerity. He is for the moſt part attentive to the duties of religion; and, except to thoſe who have injured him, courteous and kind: he is affectionate to his tutor Phenix; and not only pities the misfortunes of his enemy Priam, but in the moſt ſoothing manner adminiſters to him the beſt conſolation that Homer's poor theology could furniſh. Though no admirer of the cauſe in which his evil deſtiny compels him to engage, he is warmly attached to his native land; and, ardent as he is in vengeance, he is equally ſo in love to his aged father Peleus, and to his friend Patroclus. He is not luxurious like Paris, nor clowniſh like Ajax; his accompliſhments are princely, and his amuſements worthy of a hero. Add to this, as an apology for the vehemence of his anger, that the affront he had received was (according to the manners of that age) of the moſt atrocious nature; and not only unprovoked, but ſuch as, on the part of Agamemnon, betrayed a brutal inſenſibility to merit, as well as a proud, ſelfiſh, ungrateful, and tyrannical diſpoſition. And though he is often inexcuſably furious; yet it is but juſtice to remark, that he was not naturally cruel (E); and that his wildeſt outrages were ſuch as in thoſe rude times might be expected from a violent man of invincible ſtrength and valour, when exaſperated by injury, and frantic with ſorrow.—Our hero's claim to the admiration of mankind is indiſputable. Every part of his character is ſublime and aſtoniſhing. In his perſon, he is the ſtrongeſt, the ſwifteſt, the moſt beautiful of men:—this laſt circumſtance, however, occurs not to his own obſervation, being too trivial to attract the notice of ſo great a mind. The Fates had put it in his power, either to return home before the end of the war, or to remain at Troy:—if he choſe the former, he would enjoy tranquillity and happineſs in his own country to a good old age; if the latter, he muſt periſh in the bloom of his youth:—his affection to his father and native country, and his hatred to Agamemnon, ſtrongly urged him to the firſt; but a deſire to avenge the death of his friend determines him to accept the laſt, with all its conſequences. This at once diſplays the greatneſs of his fortitude, the warmth of his friendſhip, and the violence of his ſanguinary paſſions: and it is this that ſo often and ſo powerfully recommends him to the pity, as well as admiration, of the attentive reader." Of Poetical Characters.

It is equally a proof of rich invention and exact judgment in Homer, that he mixes ſome good qualities in all his bad characters, and ſome degree of imperfection in almoſt all his good ones.—Agamemnon, nothwithſtanding his pride, is an able general, and a valiant man, and highly eſteemed as ſuch by the greater part of the army.—Paris, though effeminate, and vain of his dreſs and perſon, is, however, good-natured, patient of reproof, not deſtitute of courage, and eminently ſkilled in muſic and other fine arts.—Ajax is a huge giant; fearleſs rather from inſenſibility to danger, and confidence in his maſſy arms, than from any nobler principle; boaſtful and rough; regardleſs of the gods, though not downright impious: yet there is in his manner ſomething of frankneſs and blunt ſincerity, which entitle him to a ſhare in our eſteem; and he is ever ready to aſſiſt his countrymen, to whom he renders good ſervice on many a perilous emergency.—The character of Helen, in ſpite of her faults, and of the many calamities whereof ſhe is the guilty cauſe, Homer has found means to recommend to our pity, and almoſt to our love; and this he does, without ſeeking to extenuate the crime of Paris, of which the moſt reſpectable perſonages in the poem are made to ſpeak with becoming abhorrence. She is ſo full of remorſe, ſo ready on every occaſion to condemn her paſt conduct, ſo affectionate to her friends, ſo willing to do juſtice to every body's merit, and withal ſo finely accompliſhed, that ſhe extorts our admiration, as well as that of the Trojan ſenators.—Menelaus, though ſufficiently ſenſible of the injury he had received, is yet a man of moderation, clemency, and good-nature, a valiant ſoldier, and a moſt affectionate brother: but there is a daſh of vanity in his compoſition, and he entertains rather too high an opinion of his own abilities, yet never overlooks nor undervalues the merit of others.—Priam would claim unreſerved eſteem, as well as pity, if it were not for his inexcuſeable weakneſs, in gratifying the humour, and by indulgence abetting the crimes, of the moſt worthleſs of all his children, to the utter ruin of his people, family, and kingdom. Madame Dacier ſuppoſes, that he had loſt his authority, and was obliged to fall in with the politics of the times: but of this there appears no evidence; 28 Of all Homer's characters. *Beattie*, ut ſupra.

(E) See *Iliad* xxi. 100. and xxiv. 485.—673.—In the firſt of theſe paſſages, Achilles himſelf declares, that before Patroclus was ſlain, he often ſpared the lives of his enemies, and took pleaſure in doing it. It is ſtrange, as Dr Beattie obſerves, that this ſhould be left out in Pope's Tranſlation.

Of Poetical Characters.

evidence; on the contrary, he and his unworthy favourite Paris seem to have been the only persons of distinction in Troy who were averse to the restoring of Helen. Priam's foible (if it can be called by so soft a name), however faulty, is not uncommon, and has often produced calamity both in private and public life. The Scripture gives a memorable instance in the history of the good old Eli.——Sarpedon comes nearer a perfect character than any other of Homer's heroes; but the part he has to act is short. It is a character which one could hardly have expected in those rude times: a sovereign prince, who considers himself as a magistrate set up by the people for the public good, and therefore bound in honour and gratitude to be himself their example, and study to excel as much in virtue as in rank and authority.——Hector is the favourite of every reader, and with good reason. To the truest valour he joins the most generous patriotism. He abominates the crime of Paris: but not being able to prevent the war, he thinks it his duty to defend his country, and his father and sovereign, to the last. He too, as well as Achilles, foresees his own death; which heightens our compassion, and raises our idea of his magnanimity. In all the relations of private life, as a son, a father, a husband, a brother, he is amiable in the highest degree; and he is distinguished among all the heroes for tenderness of affection, gentleness of manners, and a pious regard to the duties of religion. One circumstance of his character, strongly expressive of a great and delicate mind, we learn from Helen's lamentation over his dead body, that he was almost the only person in Troy who had always treated her with kindness, and never uttered one reproachful word to give her pain, nor heard others reproach her without blaming them for it. Some tendency to ostentation (which, however, may be pardonable in a commander in chief), and temporary fits of timidity, are the only blemishes discoverable in this hero; whose portrait Homer appears to have drawn with an affectionate and peculiar attention.

By ascribing so many amiable qualities to Hector and some others of the Trojans, the poet interests us in the fate of that people, notwithstanding our being continually kept in mind that they are the injurious party. And by thus blending good and evil, virtue and frailty, in the composition of his characters, he makes them the more conformable to the real appearances of human nature, and more useful as examples for our improvement; and at the same time, without hurting verisimilitude, gives every necessary embellishment to particular parts of his poem, and variety, coherence, and animation, to the whole fable. And it may also be observed, that though several of his characters are complex, not one of them is made up of incompatible parts: all are natural and probable, and such as we think we have met with, or might have met with, in our intercourse with mankind.

From the same extensive views of good and evil, in all their forms and combinations, Homer has been enabled to make each of his characters perfectly distinct in itself, and different from all the rest; insomuch, that before we come to the end of the Iliad, we are as well acquainted with his heroes, as with the faces and tempers of our most familiar friends. Virgil, by confining himself to a few general ideas of fidelity and fortitude, has made his subordinate heroes a very good sort of people;

29
Virgil fails in drawing characters.

but they are all the same, and we have no clear knowledge of any one of them. Achates is faithful, and Gyas is brave, and Cloanthus is brave; and this is all we can say of the matter. We see these heroes at a distance, and have some notion of their shape and size; but are not near enough to distinguish their features; and every face seems to exhibit the same faint and ambiguous appearance. But of Homer's heroes we know every particular that can be known. We eat, and drink, and talk, and fight, with them: we see them in action and out of it; in the field and in their tents and houses: the very face of the country about Troy we seem to be as well acquainted with as if we had been there. Similar characters there are among these heroes, as there are similar faces in every society; but we never mistake one for another. Nestor and Ulysses are both wise and both eloquent: but the wisdom of the former seems to be the effect of experience; that of the latter of genius: the eloquence of the one is sweet and copious, but not always to the purpose, and apt to degenerate into story-telling; that of the other is close, emphatical, and persuasive, and accompanied with a peculiar modesty and simplicity of manner. Homer's heroes are all valiant; yet each displays a modification of valour peculiar to himself; one is valiant from principle, another from constitution; one is rash, another cautious; one is impetuous and headstrong, another impetuous, but tractable; one is cruel, another merciful; one is insolent and ostentatious, another gentle and unassuming; one is vain of his person, another of his strength, and a third of his family.——It would be tedious to give a complete enumeration. Almost every species of the heroic character is to be found in Homer.

Of the agents in Paradise Lost, it has been observed*, that "the weakest are the highest and noblest of human beings, the original parents of mankind; with whose actions the elements consented; on whose rectitude or deviation of will depended the state of terrestrial nature, and the condition of all the future inhabitants of the globe. Of the other agents in the poem, the chief are such as it is irreverence to name on slight occasions: the rest are lower powers;

——Of which the least could wield
These elements, and arm him with the force
Of all their regions:

Powers, which only the controul of Omnipotence restrains from laying creation waste, and filling the vast expanse of space with ruin and confusion. To display the motives and actions of beings thus superior, so far as human reason can examine, or human imagination represent them, is the task which Milton undertook and performed. The characters in the Paradise Lost, which admit of examination, are those of angels and of men: of angels good and evil; of man in his innocent and sinful state.

"Among the angels, the virtue of Raphael is mild and placid, of easy condescension, and free communication: that of Michael is regal and lofty, attentive to the dignity of his own nature. Abdiel and Gabriel appear occasionally, and act as every incident requires: the solitary fidelity of Abdiel is very amiably painted.

"Of the evil angels, the characters are more diversified. To Satan such sentiments are given as suit the most

most exalted and most depraved being. Milton has been censured for the impiety which sometimes breaks from Satan's mouth; for there are thoughts, it is justly remarked, which no observation of character can justify; because no good man would willingly permit them to pass, however transiently, through his mind. This censure has been shewn to be groundless by the great critic from whom we quote. To make Satan speak as a rebel, says he, without any such expressions as might taint the readers imagination, was indeed one of the great difficulties in Milton's undertaking; and I cannot but think that he has extricated himself with great happiness. There is in Satan's speeches little that can give pain to a pious ear. The language of rebellion cannot be the same with that of obedience: the malignity of Satan foams in haughtiness and obstinacy; but his expressions are commonly general, and no otherwise offensive than as they are wicked.—The other chiefs of the celestial rebellion are very judiciously discriminated; and the ferocious character of Moloch appears, both in the battle and in the council, with exact consistency.

"To Adam and to Eve are given, during their innocence, such sentiments as innocence can generate and utter. Their love is pure benevolence and mutual veneration; their repasts are without luxury, and their diligence without toil. Their addresses to their Maker have little more than the voice of admiration and gratitude: fruition left them nothing to ask, and innocence left them nothing to fear.—But with guilt enter distrust and discord, mutual accusation and stubborn self-defence: they regard each other with alienated minds, and dread their Creator as the avenger of their transgression; at last, they seek shelter in his mercy, soften to repentance, and melt in supplication. Both before and after the fall, the different sentiments arising from difference of sex are traced out with inimitable delicacy and philosophical propriety. Adam has always that pre-eminence in dignity, and Eve in loveliness, which we should naturally look for in the father and mother of mankind."

From what has been said, it seems abundantly evident,—That the end of poetry is to please; and therefore that the most perfect poetry must be the most pleasing;—that what is unnatural cannot give pleasure; and therefore that poetry must be according to nature:—that it must be either according to real nature, or according to nature somewhat different from the reality;—that, if according to real nature, it would give no greater pleasure than history, which is a transcript of real nature;—that greater pleasure is, however, to be expected from it, because we grant it superior indulgence, in regard to fiction, and the choice of words;—and, consequently, that poetry must be, not according to real nature, but according to nature improved to that degree which is consistent with probability and suitable to the poet's purpose.—And hence it is that we call poetry, *An imitation of nature*.—For that which is properly termed *imitation* has always in it something which is not in the original. If the prototype and transcript be exactly alike; if there be nothing in the one which is not in the other; we may call the latter a *representation*, a *copy*, a *draught*, or a *picture*, of the former; but we never call it an *imitation*.

Sect. V. *Of Arrangement, Unity, Digressions.—Further remarks on Nature in Poetry.*

Of Poetical Arrangement, &c.

I. The origin of nations, and the beginnings of great events, are little known, and seldom interesting; whence the first part of every history, compared with the sequel, is somewhat dry and tedious. But a poet must, even in the beginning of his work, interest the readers, and raise high expectation; not by any affected pomp of style, far less by ample promises or bold professions; but by setting immediately before them some incident, striking enough to raise curiosity, in regard both to its causes and to its consequences. He must therefore take up his story, not at the beginning, but in the middle; or rather, to prevent the work from being too long, as near the end as possible; and afterwards take some proper opportunity to inform us of the preceding events, in the way of narrative, or by conversation of the persons introduced, or by short and natural digressions. 33 How a poem ought to begin.

The action of both the *Iliad* and *Odyssey* begins about six weeks before its conclusion; although the principal events of the war of Troy are to be found in the former; and the adventures of a ten years voyage, followed by the suppression of a dangerous domestic enemy, in the latter. One of the first things mentioned by Homer in the Iliad, is a plague, which Apollo in anger sent into the Grecian army commanded by Agamemnon and now encamped before Troy. Who this Agamemnon was, and who the Grecians were; for what reason they had come hither; how long the siege had lasted; what memorable actions had been already performed; and in what condition both parties now were:—all this, and much more, we soon learn from occasional hints and conversations interspersed through the poem.

In the *Æneid*, which, though it comprehends the transactions of seven years, opens within a few months of the concluding event, we are first presented with a view of the Trojan fleet at sea, and no less a person than Juno interesting herself to raise a storm for their destruction. This excites a curiosity to know something further: who these Trojans were, whence they had come, and whither they were bound; why they had left their own country, and what had befallen them since they left it. On all these points, the poet, without quitting the track of his narrative, soon gives the fullest information: The storm rises; the Trojans are driven to Africa, and hospitably received by the queen of the country; at whose desire their commander relates his adventures.

The action of *Paradise Lost* commences not many days before Adam and Eve are expelled from the garden of Eden, which is the concluding event. This poem, as its plan is incomparably more sublime and more important than that of either the Iliad or Æneid, opens with a far more interesting scene: a multitude of angels and archangels shut up in a region of torment and darkness, and rolling on a lake of unquenchable fire. Who these angels are, and what brought them into this miserable condition, we naturally wish to know; and the poet in due time informs us; partly from the conversation of the fiends themselves; and more particularly by the mouth of a happy spirit, sent from heaven to caution the father and mother of mankind against temptation, and confirm their good resolutions by unfolding the dreadful effects of impiety and disobedience.

7 This

Of Poetical Arrangement, &c.

Beattie, ut ſupra.

This poetical arrangement of events, ſo different from the hiſtorical, has other advantages beſides thoſe ariſing from brevity and compactneſs of detail: it is obviouſly more affecting to the fancy, and more alarming to the paſſions; and, being more ſuitable to the order and the manner in which the actions of other men ſtrikes our ſenſes, is a more exact imitation of human affairs.

34 The advantages of the poetical arrangement.

I hear a ſudden noiſe in the ſtreet, and run to ſee what is the matter. An inſurrection has happened, a great multitude is brought together, and ſomething very important is going forward. The ſcene before me is the firſt thing that engages my attention; and is in itſelf ſo intereſting, that for a moment or two I look at it in ſilence and wonder. By and by, when I get time for reflection, I begin to inquire into the cauſe of all this tumult, and what it is the people would be at; and one who is better informed than I, explains the affair from the beginning; or perhaps I make this out for myſelf, from the words and actions of the perſons principally concerned.—This is a ſort of picture of poetical arrangement, both in epic and dramatic compoſition; and this plan has been followed in narrative odes and ballads both ancient and modern.—The hiſtorian purſues a different method. He begins perhaps with an account of the manners of a certain age, and of the political conſtitution of a certain country; then introduces a particular perſon, gives the ſtory of his birth, connections, private character, purſuits, diſappointments, and of the events that promoted his views, and brought him acquainted with other turbulent ſpirits like himſelf; and ſo proceeds, unfolding, according to the order of time, the cauſes, principles, and progreſs of the conſpiracy, if that be the ſubject which he undertakes to illuſtrate. It cannot be denied, that this latter method is more favourable to calm information: but the former, compared with it, will be found to have all the advantages already ſpecified, and to be more effectually productive of that mental pleaſure which depends on the paſſions and imagination.

35 Unity of deſign neceſſary to the higher poetry.

II. If a work have no determinate end, it has no meaning; and if it have many ends, it will diſtract by its multiplicity. Unity of deſign, therefore, belongs in ſome meaſure to all compoſitions, whether in verſe or proſe. But to ſome it is more eſſential than to others; and to none ſo much as in the higher poetry. In certain kinds of hiſtory, there is unity ſufficient if all the events recorded be referred to one perſon; in others, if to one period of time, or to one people, or even to the inhabitants of one and the ſame planet. But it is not enough that the ſubject of a poetical fable be the exploits of one perſon; for theſe may be of various and even of oppoſite ſorts and tendencies, and take up longer time than the nature of poetry can admit:—far leſs can a regular poem comprehend the affairs of one period or of one people:—it muſt be limited to one great action or event, to the illuſtration of which all the ſubordinate events muſt contribute; and theſe muſt be ſo connected with one another, as well as with the poet's general purpoſe, that one cannot be changed, tranſpoſed, or taken away, without affecting the conſiſtence and ſtability of the whole *. In itſelf an incident may be intereſting, a character well drawn, a deſcription beautiful; and yet, if it disfigure the general plan, or if it obſtruct or incumber the main action, inſtead of helping it forward, a correct artiſt would conſider it but as a gaudy ſuperfluity or ſplendid deformity; like a piece of ſcarlet cloth ſewed upon a garment of a different colour †. Not that all the parts of the fable either are, or can be, equally eſſential. Many deſcriptions and thoughts, of little conſequence to the plan, may be admitted for the ſake of variety; and the poet may, as well as the hiſtorian and philoſopher, drop his ſubject for a time, in order to take up an affecting or inſtructive digreſſion.

* Ariſt. Poet. § 8.

III. The doctrine of poetical digreſſions and epiſodes has been largely treated by the critics. We ſhall here only remark, that, in eſtimating their propriety, three things are to be attended to:—their connection with the fable or ſubject; their own peculiar excellence; and their ſubſerviency to the poet's deſign.

(1.) Thoſe digreſſions that both ariſe from and terminate in the ſubject, like the epiſode of the angel Raphael in Paradiſe Loſt, and the tranſition to the death of Cæſar and the civil wars in the firſt book of the Georgic, are the moſt artful, and if ſuitably executed claim the higheſt praiſe:—thoſe that ariſe from, but do not terminate in, the ſubject, are perhaps ſecond in the order of merit; like the ſtory of Dido in the Æneid, and the encomium on a country life in the ſecond book of the Georgic:—thoſe come next that terminate in, but do not riſe from, the fable; of which there are ſeveral in the third book of the Æneid, and in the Odyſſey:—and thoſe that neither terminate in the fable nor riſe from it are the leaſt artful; and if they be long, cannot eſcape cenſure, unleſs their beauty be very great.

But (2.) we are willing to excuſe a beautiful epiſode at whatever expence to the ſubject it may be introduced. They who can blame Virgil for obtruding upon them the charming tale of Orpheus and Euridice in the fourth Georgic, or Milton for the apoſtrophe to light in the beginning of his third book, ought to forfeit all title to the peruſal of good poetry; for of ſuch divine ſtrains one would rather be the author than of all the books of criticiſm in the world. Yet ſtill it is better that an epiſode poſſeſs the beauty of connection, together with its own intrinſic elegance, than this without the other.

Moreover, in judging of the propriety of epiſodes and other ſimilar contrivances, it may be expedient to attend (3.) to the deſign of the poet, as diſtinguiſhed from the fable or ſubject of the poem. The great deſign, for example, of Virgil, was to intereſt his countrymen in a poem written with a view to reconcile them to the perſon and government of Auguſtus. Whatever, therefore, in the poem tends to promote this deſign, even though it ſhould in ſome degree hurt the contexture of the fable, is really a proof of the poet's judgment; and may be not only allowed, but applauded.—The progreſs of the action of the Æneid may ſeem to be too long obſtructed in one place by the ſtory of Dido, which, though it riſes from the preceding part of the poem, has no influence upon the ſequel; and, in another, by the epiſode of Cacus, which, without injury to the fable, might have been omitted altogether. Yet theſe epiſodes, intereſting as they are to us and all mankind becauſe of the tranſcendant merit of the poetry, muſt have been ſtill more intereſting to the Romans becauſe of their connection with the Roman affairs; for the one accounts poetically for their wars with Carthage; and the other not only explains ſome of their religious ceremonies, but alſo gives a moſt charming rural picture of thoſe hills and valleys in the neighbourhood of the Tiber, on which,

in after times, their majestic city was fated to stand.—And if we consider, that the design of Homer's Iliad was not only to show the fatal effects of dissension among confederates, but also to immortalize his country, and celebrate the most distinguished families in it, we shall be inclined to think more favourably than critics generally do of some of his long speeches and digressions; which, though to us they may seem trivial, must have been very interesting to his countrymen on account of the genealogies and private history recorded in them.—Shakespeare's historical plays, considered as dramatic fables, and tried by the laws of tragedy and comedy, appear very rude compositions; but if we attend to the poet's design (as the elegant critic * has with equal truth and beauty explained it), we shall be forced to admire his judgment in the general conduct of those pieces, as well as unequalled success in the execution of particular parts.

There is yet another point of view in which these digressions may be considered. If they tend to elucidate any important character, or to introduce any interesting event not otherwise within the compass of the poem, or to give an amiable display of any particular virtue, they may be intitled, not to our pardon only, but even to our admiration, however loosely they may hang upon the fable. All these three ends are effected by that most beautiful episode of Hector and Andromache in the sixth book of the Iliad; and the two last, by the no less beautiful one of Euryalus and Nisus in the ninth of the Æneid.

IV. And now, from the position formerly established, that the end of this divine art is to give pleasure, it has been endeavoured to prove, that, whether in displaying the appearances of the material universe, or in imitating the workings of the human mind, and the varieties of human character, or in arranging and combining into one whole the several incidents and parts whereof his fable consists,—the aim of the poet must be to copy nature, not as it is, but in that state of perfection in which, consistently with the particular genius of the work, and the laws of verisimilitude, it may be supposed to be.

Such, in general, is the nature of that poetry which is intended to raise admiration, pity, and other serious emotions. But in this art, as in all others, there are different degrees of excellence; and we have hitherto directed our view chiefly to the highest. All serious poets are not equally solicitous to improve nature. Euripides is said to have represented men as they were; Sophocles, more poetically, as they should or might be †. Theocritus in his Idyls, and Spencer in his Shepherd's Calendar, give us language and sentiments more nearly approaching those of the *Rus verum et barbarum* ‡, than what we meet with in the Pastorals of Virgil and Pope. In the historical drama, human characters and events must be according to historical truth, or at least not so remote from it as to lead into any important misapprehension of fact. And in the historical epic poem, such as the Pharsalia of Lucan, and the Campaign of Addison, the historical arrangement is preferred to the poetical, as being nearer the truth. Yet nature is a little improved even in these poems. The persons in Shakespeare's historical plays, and the heroes of the Pharsalia, talk in verse, and suitably to their characters, and with a readiness, beauty, and harmony of expression, not to be met with in real life, nor even in history: speeches are invented, and, to heighten the description, circumstances added, with great latitude: real events are rendered more compact and more strictly dependent upon one another; and fictitious ones brought in, to elucidate human characters and diversify the narration.

Of Poetical Arrangement, &c.

The more poetry improves nature, by copying after general ideas collected from extensive observation, the more it partakes (according to Aristotle) of the nature of philosophy; the greater stretch of fancy and of observation it requires in the artist, the better chance it has to be universally agreeable.

41 When poetry falls short of this perfection it may have great merit in other respects.

Yet poetry, when it falls short of this perfection, may have great merit as an instrument of both instruction and pleasure. To most men, simple unadorned nature is, at certain times, and in certain compositions, more agreeable than the most elaborate improvements of art; as a plain short period, without modulation, gives a pleasing variety to a discourse. Many such portraits of simple nature there are in the subordinate parts both of Homer's and of Virgil's poetry: and an excellent effect they have in giving probability to the fiction, as well as in gratifying the reader's fancy with images distinct and lively, and easily comprehended. The historical plays of Shakespeare raise not our pity and terror to such a height as Lear, Macbeth, or Othello; but they interest and instruct us greatly notwithstanding. The rudest of the eclogues of Theocritus, or even of Spenser, have by some authors been extolled above those of Virgil, because more like real life. Nay, Corneille is known to have preferred the Pharsalia to the Æneid, perhaps from its being nearer the truth, or perhaps from the sublime sentiments of stoical morality so forcibly and so ostentatiously displayed in it.

Poets may refine upon nature too much as well as too little; for affectation and rusticity are equally remote from true elegance. The style and sentiments of comedy should no doubt be more correct and more pointed than those of the most polite conversation: but to make every footman a wit, and every gentleman and lady an epigrammatist, as Congreve has done, is an excessive and faulty refinement. The proper medium has been hit by Menander and Terence, by Shakespeare in his happier scenes, and by Garrick, Cumberland, and some others of late renown. To describe the passion of love with as little delicacy as some men speak of it would be unpardonable; but to transform it into mere Platonic adoration is to run into another extreme, less criminal indeed, but too remote from universal truth to be universally interesting. To the former extreme Ovid inclines, and Petrarch and his imitators to the latter. Virgil has happily avoided both: but Milton has painted this passion as distinct from all others, with such peculiar truth and beauty, that we cannot think Voltaire's encomium too high, when he says, that love in all other poetry seems a weakness, but in Paradise Lost a virtue. There are many good strokes of nature in Ramsay's Gentle Shepherd; but the author's passion for the *rus verum* betrays him into some indelicacies: a censure that falls with greater weight upon Theocritus, who is often absolutely indecent. The Italian pastoral of Tasso and Guarini, and the French of Fontenelle, run into the opposite extreme (though in some parts beautifully simple), and display a system of rural manners so quaint and

Of Poetical Language.

and affected as to outrage all probability. In fine, though mediocrity of execution in poetry be allowed to deſerve the doom pronounced upon it by Horace; yet it is true, notwithſtanding, that in this art, as in many other good things, the point of excellence lies in a middle between two extremes; and has been reached by thoſe only who ſought to improve nature as far as the genius of their work would permit, keeping at an equal diſtance from ruſticity on the one hand, and affected elegance on the other.

Sect. VI. *Of Poetical Language.*

42 Words in poetry to be choſen for their ſenſe and for their ſound.

Words in poetry are choſen, firſt, for their *ſenſe*; and, ſecondly, for their *ſound*. That the firſt of theſe grounds of choice is the more excellent nobody can deny. He who in literary matters prefers ſound to ſenſe is a fool. Yet ſound is to be attended to even in proſe, and in verſe demands particular attention. We ſhall conſider poetical language, firſt, as SIGNIFICANT; and, ſecondly, as SUSCEPTIBLE OF HARMONY.

§ 1. *Of Poetical Language conſidered as* SIGNIFICANT.

43 The language of poetry an imitation of the language of nature,

If, as it has been endeavoured to prove, poetry be imitative of nature, poetical fictions of real events, poetical images of real appearances in the viſible creation, and poetical perſonages of real human characters; it would ſeem to follow, that the *language of poetry* muſt be an imitation of the *language of nature*.

According to Dr Beattie *, that language is natural which is ſuited to the ſpeaker's condition, character, and circumſtances. And as, for the moſt part, the images and ſentiments of ſerious poetry are copied from the images and ſentiments, not of real, but of improved, nature; ſo the language of ſerious poetry muſt (as hinted already) be a tranſcript, not of the real language of nature, which is often diſſonant and rude, but of natural language improved as far as may be conſiſtent with probability, and with the ſuppoſed character of the ſpeaker. If this be not the caſe, if the language of poetry be ſuch only as we hear in converſation or read in hiſtory, it will, inſtead of delight, bring diſappointment: becauſe it will fall ſhort of what we expect from an art which is recommended rather by its pleaſurable qualities than by its intrinſic utility; and to which, in order to render it pleaſing, we grant higher privileges than to any other kind of literary compoſition, or any other mode of human language.

* *Eſſays*, Part ii. chap. 1.

44 Improved as far as may be conſiſtent with probability, &c.

The next inquiry muſt therefore be, "What are thoſe improvements that peculiarly belong to the language of poetry?" And theſe may be comprehended under two heads; *poetical words*, and *tropes and figures*.

Art. I. Of Poetical Words.

45 All languages have words peculiar to poetry.

One mode of improvement peculiar to poetical diction reſults from the uſe of thoſe words and phraſes which, becauſe they rarely occur in proſe, and frequently in verſe, are by the grammarian and lexicographer termed *poetical*. In theſe ſome languages abound more than others; but no language perhaps is altogether without them, and perhaps no language can be ſo in which any number of good poems have been written: for poetry is better remembered than proſe, eſpecially by poetical authors, who will always be apt to imitate the phraſeology of thoſe they have been accuſtomed to read and admire; and thus, in the works of poets down through ſucceſſive generations, certain phraſes may have been conveyed, which, though originally perhaps in common uſe, are now confined to poetical compoſition. Proſe writers are not ſo apt to imitate one another, at leaſt in words and phraſes, both becauſe they do not ſo well remember one another's phraſeology, and alſo becauſe their language is leſs artificial, and muſt not, if they would make it eaſy and flowing (without which it cannot be elegant), depart eſſentially from the ſtyle of correct converſation. Poets, too, on account of the greater difficulty of their numbers, have, both in the choice and in the arrangement of words, a better claim to indulgence, and ſtand more in need of a diſcretionary power.

The language of Homer differs materially from what was written and ſpoken in Greece in the days of Socrates. It differs in the mode of inflection, it differs in the ſyntax, it differs even in the words: ſo that one might read Homer with eaſe who could not read Xenophon; or Xenophon, without being able to read Homer. Yet we cannot believe that Homer, or the firſt Greek poet who wrote in his ſtyle, would make choice of a dialect quite different from what was intelligible in his own time: for poets have in all ages written with a view to be read, and to be read with pleaſure; which they could not be if their diction were hard to be underſtood. It is more reaſonable to ſuppoſe that the language of Homer is according to ſome ancient dialect, which, though not perhaps in familiar uſe among the Greeks at the time he wrote, was however intelligible. From the Homeric to the Socratic age, a period had elapſed of no leſs than 400 years; during which the ſtyle both of diſcourſe and of writing muſt have undergone great alterations. Yet the Iliad continued the ſtandard of heroic poetry, and was conſidered as the very perfection of poetical language; notwithſtanding that ſome words in it were become ſo antiquated, or ſo ambiguous, that Ariſtotle himſelf ſeems to have been ſomewhat doubtful in regard to their meaning *. And if Chaucer's merit as a poet had been as great as Homer's, and the Engliſh tongue under Edward III. as perfect as the Greek was in the ſecond century after the Trojan war, the ſtyle of Chaucer would probably have been our model for poetical diction at this day; even as Petrarch, his contemporary, is ſtill imitated by the beſt poets of Italy.

The rudeneſs of the ſtyle of Ennius has been imputed by the old critics to his having copied too cloſely the dialect of common life. But this appears to be a miſtake. For if we compare the fragments of that author with the comedies of Plautus, who flouriſhed in the ſame age, and whoſe language was certainly copied from that of common life, we ſhall be ſtruck with an air of antiquity in the former that is not in the latter. Ennius, no doubt, like moſt other ſublime poets, affected ſomething of the antique in his expreſſion; and many of his words and phraſes, not adopted by any proſe-writer now extant, are to be found in Lucretius and Virgil, and were by them tranſmitted to ſucceeding poets. Theſe form part of the Roman poetical dialect; which appears from the writings of Virgil, where we have it in perfection, to have been very copious. The ſtyle of this charming poet is indeed ſo different from proſe, and is altogether ſo peculiar, that it is perhaps impoſſible to analyſe it on the common principles of

of Latin grammar. And yet no author can be more perſpicuous or more expreſſive; notwithſtanding the frequency of Greciſm in his ſyntax, and his love of old words, which he, in the judgment of Quintilian, knew better than any other man how to improve into decoration *.

§ 3. The poetical dialect of modern Italy is ſo different from the proſaic, that perſons who can read the hiſtorians, and even ſpeak with tolerable fluency the language of that country, may yet find it difficult to conſtrue a page of Petrarch or Taſſo. Yet it is not probable, that Petrarch, whoſe works are a ſtandard of the Italian poetical diction †, made any material innovations in his native tongue. It is rather probable that he wrote it nearly as it was ſpoken in his time, that is, in the 14th century; omitting only harſh combinations, and taking that liberty which Homer probably, and Virgil certainly, took before him, of reviving ſuch old, but not obſolete expreſſions, as ſeemed peculiarly ſignificant and melodious; and poliſhing his ſtyle to that degree of elegance which human ſpeech, without becoming unnatural, may admit of, and which the genius of poetry, as an art ſubſervient to pleaſure, may be thought to require.

The French poetry in general is diſtinguiſhed from proſe rather by the rhime and the meaſure, than by any old or uncommon phraſeology. Yet the French, on certain ſubjects, imitate the ſtyle of their old poets, of Marot in particular; and may therefore be ſaid to have ſomething of a poetical dialect, though far leſs extenſive than the Italian, or even than the Engliſh. And it may be preſumed, that in future ages they will have more of this dialect than they have at preſent. This may be inferred from the very uncommon merit of ſome of their late poets, particularly Boileau and La Fontaine, who, in their reſpective departments, will continue to be imitated, when the preſent modes of French proſe are greatly changed: an event that, for all the pains they take to preſerve their language, muſt inevitably happen, and whereof there are not wanting ſome preſages already.

The Engliſh poetical dialect is not characteriſed by any peculiarities of inflection, nor by any great latitude in the uſe of foreign idioms. More copious it is, however, than one would at firſt imagine; as may appear from the following ſpecimen and obſervations.

(1.) A few Greek and Latin idioms are common in Engliſh poetry, which are ſeldom or never to be met with in proſe. QUENCHED OF HOPE. Shakeſpeare.—SHORN OF HIS BEAMS. Milton.—*Created thing* NOR VALUED HE NOR SHUN'D. Milton.—*'Tis thus we riot, while* WHO SOW IT STARVE. Pope.—*This day* BE BREAD AND PEACE MY LOT. Pope.—INTO WHAT PIT THOU SEE'ST FROM WHAT HEIGHT FALLEN. Milton. *He deceived The mother of mankind,* WHAT TIME HIS PRIDE HAD CAST HIM *out of heaven.* Milton.——Some of theſe, with others to be found in Milton, ſeem to have been adopted for the ſake of brevity, which in the poetical tongue is indiſpenſable. For the ſame reaſon, perhaps the articles *a* and *the* are ſometimes omitted by our poets, though leſs frequently in ſerious than burleſque compoſition.——In Engliſh, the adjective generally goes before the ſubſtantive, the nominative before the verb, and the active verb before (what we call) the accuſative. Exceptions, however, to this rule, are not uncommon even in proſe. But in poetry they are more frequent. *Their homely joys, and* DESTINY OBSCURE. *Now fades the glimmering landſcape on the ſight; and all the air a ſolemn ſtillneſs holds.* In general, that verſification may be leſs difficult, and the cadence more uniformly pleaſing; and ſometimes, too, in order to give energy to expreſſion, or vivacity to an image;—the Engliſh poet is permitted to take much greater liberties than the proſe-writer, in arranging his words, and modulating his lines and periods. Examples may be ſeen in every page of Paradiſe Loſt.

Of Poetical Words.

(2.) Some of our poetical words take an additional ſyllable, that they may ſuit the verſe the better; as, *diſpart, diſtain, diſport, affright, enchain,* for part, ſtain, ſport, fright, chain. Others ſeem to be nothing elſe than common words made ſhorter, for the convenience of the verſifier. Such are, *auxiliar, ſublunar, trump, vale, part, clime, ſubmiſs, frolic, plain, drear, dread, helm, morn, mead, eve* and *even, gan, illume* and *illumine, ope, hoar, bide, ſwage, ſcape;* for auxiliary, ſublunary, trumpet, valley, depart, climate, ſubmiſſive, frolicſome, complain, dreary, dreadful, helmet, morning, meadow, evening, began or began to, illuminate, open, hoary, abide, aſſuage, eſcape.——Of ſome of theſe the ſhort form is the more ancient. In Scotland, *even, morn, bide, ſwage,* are ſtill in vulgar uſe; but *morn,* except when contradiſtinguiſhed to *even,* is ſynonymous, not with *morning* (as in the Engliſh poetical dialect), but with *morrow.*—The Latin poets, in a way ſomewhat ſimilar, and perhaps for a ſimilar reaſon, ſhortened *fundamentum, tutamentum, munimentum,* &c. into fundamen, tutamen, munimen.

(3.) Of the following words, which are now almoſt peculiar to poetry, the greater part are ancient, and were once no doubt in common uſe in England, as many of them ſtill are in Scotland. *Afield, amain, annoy* (a noun), *anon, aye* (ever), *beheſt, blithe, brand* (ſword), *bridal, carol, dame* (lady), *featly, fell* (an adjective), *gaude, gore, hoſt* (army), *lambkin, late* (of late), *lay* (poem), *lea, glade, gleam, hurl, lore, meed, oriſons, plod* (to travel laboriouſly), *ringlet, rue* (a verb), *ruth, ruthleſs, ſojourn* (a noun), *ſmite, ſpeed* (an active verb), *ſave* (except), *ſpray* (twig), *ſteed, ſtrain* (ſong), *ſtrand, ſwain, thrall, thrill, trail* (a verb), *troll, wail, welter, warble, wayward, woo, the while* (in the mean time), *yon, of yore.*

(4.) Theſe that follow are alſo poetical; but, ſo far as appears, were never in common uſe. *Appal, arrowy, attune, battailous, breezy, car* (chariot), *clarion, cates, courſer, darkling, flicker, floweret, emblaze, gairiſh, circlet, impearl, nightly, noiſeleſs, pinion* (wing), *ſhadowy, ſlumberous, ſtreamy, troublous, wilder* (a verb), *ſhrill* (a verb), *ſhook* (ſhaken), *madding, viewleſs.*—The following, too, derived from the Greek and Latin, ſeem peculiar to poetry. *Clang, clangor, choral, bland, boreal, dire, enſanguined, ire, ireful, lave* (to waſh), *nymph* (lady, girl), *orient, panoply, philomel, infuriate, jocund, radiant, rapt, redolent, refulgent, verdant, vernal, zephyr, zone* (girdle), *ſylvan, ſuffuſe.*

(5.) In moſt languages, the rapidity of pronunciation abbreviates ſome of the commoneſt words, or even joins two, or perhaps more, of them, into one; and ſome of thoſe abbreviated forms find admiſſion into writing. The Engliſh language was quite disfigured by them

Of Poetical Words. them in the end of the last century; but Swift, by his satire and example, brought them into disrepute: and, though some of them be retained in conversation, as *don't, shan't, can't*, they are now avoided in solemn style; and by elegant writers in general, except where the colloquial dialect is imitated, as in comedy. *'Tis* and *'twas*, since the time of Shaftesbury, seem to have been daily losing credit, at least in prose; but still have a place in poetry, perhaps because they contribute to conciseness. *'Twas on a lofty vase's side.* Gray.—*'Tis true, 'tis certain, man, though dead, retains part of himself.* Pope. In verse too, *over* may be shortened into *o'er*, (which is the Scotch, and probably was the old English, pronunciation); *never* into *ne'er*; and from *the* and *to*, when they go before a word beginning with a vowel, the final letter is sometimes cut off. *O'er hills, o'er dales, o'er crags, o'er rocks they go.* Pope.—*Where'er she turns, the Graces homage pay. And all that beauty, all that wealth e'er gave. Rich with the spoils of time did ne'er unroll.* Gray.—*T'alarm th' eternal midnight of the grave.*—These abbreviations are now peculiar to the poetical tongue, but not necessary to it. They sometimes promote brevity, and render versification less difficult.

(6.) Those words which are commonly called *compound epithets*, as *rosy-finger'd, rosy-bosom'd, many-twinkling, many-sounding, moss-grown, bright-eyed, straw-built, spirit-stirring, incense-breathing, heaven-taught, love-whispering, lute-resounding*, are also to be considered as part of our poetical dialect. It is true, we have compounded adjectives in familiar use, as *high-seasoned, well-natured, ill-bred*, and innumerable others. But we speak of those that are less common, that seldom occur except in poetry, and of which in prose the use would appear affected. And that they sometimes promote brevity and vivacity of expression, cannot be denied. But as they give, when too frequent, a stiff and finical air to a performance; as they are not always explicit in the sense, nor agreeable in the sound; as they are apt to produce a confusion, or too great a multiplicity, of images; as they tend to disfigure the language, and furnish a pretext for endless innovation; they ought to be used sparingly; and those only used which the practice of popular authors has rendered familiar to the ear, and which are in themselves peculiarly emphatical and harmonious.

48 To be used sparingly.

(7.) In the transformation of nouns into verbs and participles, our poetical dialect admits of greater latitude than prose. Hymn, pillow, curtain, story, pillar, picture, peal, surge, cavern, honey, career, cincture, bosom, sphere, are common nouns; but *to hymn, to pillow, curtained, pillared, pictured, pealing, surging, cavern'd, honied, careering, cinctured, bosomed, sphered*, would appear affected in prose, and yet in verse they are warranted by great authorities, though it must be confessed that they are censured by an able critic *, who had studied the English language, both poetical and prosaic, with wonderful diligence.

* *Johnson.*

Some late poets, particularly the imitators of Spencer, have introduced a great variety of uncommon words, as certes, eftsoons, ne, whilom, transmew, moil, sone, losel, albe, hight, dight, pight, thews, couthful, assot, muchel, wend, arrear, &c. These were once poetical words, no doubt; but they are now obsolete, and to many readers unintelligible. No man of the present age, however conversant in this dialect, would naturally express himself in it on any interesting emergence; or, supposing this natural to the antiquarian, it would never appear so to the common hearer or reader. A mixture of these words, therefore, must ruin the pathos of modern language; and as they are not familiar to our ear, and plainly appear to be sought after and affected, will generally give a stiffness to modern versification. Yet in subjects approaching to the ludicrous they may have a good effect; as in the *Schoolmistress* of Shenstone, Parnel's Fairy-tale, Thomson's Castle of Indolence, and Pope's lines in the Dunciad upon Wormius. But this effect will be most pleasing to those who have least occasion to recur to the glossary.

Indeed, it is not always easy to fix the boundary between poetical and obsolete expressions. To many readers, *lore, meed, behest, blithe, gaude, spray, thrall*, may already appear antiquated; and to some the style of Spencer, or even of Chaucer, may be as intelligible as that of Dryden. This however we may venture to affirm, that a word, which the majority of readers cannot understand without a glossary, may with reason be considered as obsolete; and ought not to be used in modern composition, unless revived, and recommended to the public ear, by some very eminent writer. There are but few words in Milton, as *nathless, tine, frore, bosky*, &c.; there are but one or two in Dryden, as *falsify* (F); and in Pope, there are none at all, which every reader of our poetry may not be supposed to understand: whereas in Shakespeare there are many, and in Spencer many more, for which one who knows English very well may be obliged to consult the dictionary. The practice of Milton, Dryden, or Pope, may therefore, in almost all cases, be admitted as good authority for the use of a poetical word. And in them, all the words above enumerated, as poetical, and in present use, may actually be found. And of such poets as may choose to observe this rule, it will not be said, either that they reject the judgment of Quintilian, who recommends the newest of the old words, and the oldest of the new, or that they are inattentive to Pope's precept;

Be not the first by whom the new are tried,
Nor yet the last to lay the old aside.

Ess. on Crit. v. 335.

We must not suppose that these poetical words never occur at all except in poetry. Even from conversation they are not excluded: and the ancient critics allow, that they may be admitted into prose, where they occasionally confer dignity upon a sublime subject, or heighten the ludicrous qualities of a mean one. But it is in poetry only where the frequent use of them does not favour of affectation.

Nor must we suppose them essential to this art. Many

(F) Dryden in one place (Æneid ix. vers. 1095.) uses *Falsified* to denote *Pierced through and through.* He acknowledges, that this use of the word is an innovation; and has nothing to plead for it but his own authority, and that *Falsare* in Italian sometimes means the same thing.

Many passages there are of exquisite poetry, wherein not a single phrase occurs that might not be used in prose. In fact, the influence of these words in adorning English verse is not very extensive. Some influence however they have. They serve to render the poetical style, first, more melodious; and, secondly, more solemn.

First, They render the poetical style more melodious, and more easily reducible into measure. Words of unwieldy size, or difficult pronunciation, are never used by correct poets, where they can be avoided: unless in their sound they have something imitative of the sense. Homer's poetical inflections contribute wonderfully to the sweetness of his numbers: and if the reader is pleased to look back to the specimen above given of the English poetical dialect, he will find that the words are in general well-sounding, and such as may coalesce with other words, without producing harsh combinations. Quintilian observes, that poets, for the sake of their verse, are indulged in many liberties, not granted to the orator, of lengthening, shortening, and dividing their words *:—and if the Greek and Roman poets claimed this indulgence from necessity, and obtained it, the English, those of them especially who write in rhyme, may claim it with better reason; as the words of their language are less musical and far less susceptible of variety in arrangement and syntax.

Secondly, Such poetical words as are known to be ancient have something venerable in their appearance, and impart a solemnity to all around them. This remark is from Quintilian; who adds, that they give to a composition that cast and colour of antiquity which in painting is so highly valued, but which art can never effectually imitate †. Poetical words that are either not ancient, or not known to be such, have, however, a pleasing effect from association. We are accustomed to meet with them in sublime and elegant writing; and hence they come to acquire sublimity and elegance: Even as the words we hear on familiar occasions come to be accounted familiar; and as those that take their rise among pick-pockets, gamblers, and gypsies, are thought too indelicate to be used by any person of taste or good manners. When one hears the following lines, which abound in poetical words,

> The breezy call of incense-breathing morn,
> The swallow twittering from the straw-built shed,
> The cock's shrill clarion, or the echoing horn,
> No more shall rouse them from their lowly bed:

—one is as sensible of the dignity of the language, as one would be of the vileness or vulgarity of that man's speech, who should prove his acquaintance with Bridewell, by interlarding his discourse with such terms as *mill-doll*, *queer cull*, or *nubbing cheat* ‡; or who, in imitation of fops and gamblers, should on the common occasions of life, talk of being *beat hollow*, or *saving his distance* §. What gives dignity to persons gives dignity to language. A man of this character is one who has borne important employments, been connected with honourable associates, and never degraded himself by levity or immorality of conduct. Dignified phrases are those which have been used to express elevated sentiments, have always made their appearance in elegant composition, and have never been profaned by giving permanency or utterance to the passions of the vile, the giddy, or the worthless. And as by an active old age, the dignity of such men is confirmed and heightened; so the dignity of such words, if they be not suffered to fall into disuse, seldom fails to improve by length of time.

Of Tropes and Figures.

Art. II. Of Tropes and Figures.

51 Tropes and figures necessary to poetical language.

If it appear that, by means of figures, language may be made more *pleasing* and more natural than it would be without them; it will follow, that to poetic language, whose end is to *please* by imitating *nature*, figures must be not only ornamental, but necessary. It will here be proper, therefore, first to point out the importance and utility of figurative language; secondly, to show, that figures are more necessary to poetry in general than to any other mode of writing.

I. *As to the importance and utility of figurative expression*, in making language more pleasing and more natural; it may be remarked,

(1.) That tropes and figures are often necessary to supply the unavoidable defects of language. When *proper* words are wanting, or not recollected, or when we do not choose to be always repeating them, we must have recourse to tropes and figures. When philosophers began to explain the operations of the mind, they found that most of the words in common use, being framed to answer the more obvious exigencies of life, were in their proper signification applicable to matter only and its qualities. What was to be done in this case? Would they think of making a new language to express the qualities of mind? No: that would have been difficult or impracticable; and granting it both practicable and easy, they must have foreseen, that nobody would read or listen to what was thus spoken or written in a new and consequently in an unknown tongue. They therefore took the language as they found it; and wherever they thought there was a similarity or analogy between the qualities of the mind and the qualities of matter, scrupled not to use the names of the material qualities tropically, by applying them to the mental qualities. Hence came the phrases *solidity* of judgment, *warmth* of imagination, *enlargement* of understanding, and many others; which, though figurative, express the meaning just as well as proper words would have done. In fact, numerous as the words in every language are, they must always fall short of the unbounded variety of human thoughts and perceptions. Tastes and smells are almost as numerous as the species of bodies. Sounds admit of perceptible varieties that surpass all computation, and the seven primary colours may be diversified without end. If each variety of external perception were to have a name, language would be insurmountably difficult; nay, if men were to appropriate a class of names to each particular sense, they would multiply words exceedingly, without adding any thing to the clearness of speech. Those words, therefore, that in their proper signification denote the objects of one sense, we often apply tropically to the objects of another, and say, Sweet taste, sweet smell, sweet sound; sharp point, sharp taste, sharp sound; harmony of sounds, harmony of colours, harmony of parts; soft silk, soft colour, soft sound, soft temper; and so in a thousand instances: and yet these words, in their tropical signification, are not less intelligible than in their proper one; for sharp taste and sharp sound, are as expressive as sharp sword; and harmony of tones is not better understood by the musician, than har-

52 To supply the defects of simple language, and

mony-

Of Tropes and Figures.

mony of parts by the architect, and harmony of colours by the painter.

Savages, illiterate persons, and children, have comparatively but few words in proportion to the things they may have occasion to speak of; and must therefore recur to tropes and figures more frequently than persons of copious elocution. A seaman, or mechanic, even when he talks of that which does not belong to his art, borrows his language from that which does; and this makes his diction figurative to a degree that is sometimes entertaining enough. "Death (says a seaman in one of Smollet's novels) has not yet *boarded* my comrade; but they have been *yard-arm and yard-arm* these *three glasses*. His *starboard* eye is open, but fast *jammed* in his head; and the *haulyards* of his under jaw have given way." These phrases are exaggerated; but we allow them to be natural, because we know that illiterate people are apt to make use of tropes and figures taken from their own trade, even when they speak of things that are very remote and incongruous. In those poems, therefore, that imitate the conversation of illiterate persons, as in comedy, farce, and pastoral, such figures judiciously applied may render the imitation more pleasing, because more exact and natural.

53 To avoid harshness of diction.

Words that are untuneable and harsh, the poet is often obliged to avoid, when perhaps he has no other way to express their meaning than by tropes and figures; and sometimes the measure of his verse may oblige him to reject a proper word that is not harsh, merely on account of its being too long, or too short, or in any other way unsuitable to the rhythm, or to the rhyme. And hence another use of figurative language, that it contributes to poetical harmony. Thus, *to press the plain*, is frequently used to signify *to be slain in battle*; *liquid plain* is put for *ocean*, *blue serene* for *sky*, and *sylvan reign* for *country life*.

54 Tropes and figures favourable to delicacy.

(2.) Tropes and figures are favourable to delicacy. When the proper name of a thing is in any respect unpleasant, a well-chosen trope will convey the idea in such a way as to give no offence. This is agreeable, and even necessary, in polite conversation, and cannot be dispensed with in elegant writing of any kind. Many words, from their being often applied to vulgar use, acquire a meanness that disqualifies them for a place in serious poetry; while perhaps, under the influence of a different system of manners, the corresponding words in another language may be elegant, or at least not vulgar. When one reads Homer in the Greek, one takes no offence at his calling Eumeus by a name which, literally rendered, signifies *swine-herd*; first, because the Greek word is well-sounding in itself; secondly, because we have never heard it pronounced in conversation, nor consequently debased by vulgar use; and, thirdly, because we know, that the office denoted by it was, in the age of Eumeus, both important and honourable. But Pope would have been blamed, if a name so indelicate as *swine-herd* had in his translation been applied to so eminent a personage; and therefore he judiciously makes use of the trope *synecdoche*, and calls him *swain* *; a word both elegant and poetical, and not likely to lead the reader into any mistake about the person spoken of, as his employment had been described in a preceding passage. The same Eumeus is said, in the simple but melodious language of the original, to have been making his own shoes when Ulysses came to his door; a work which in those days the greatest heroes would often find necessary. This, too, the translator softens by a tropical expression:

> Here sat Eumeus, and his cares applied,
> To form strong *buskins* of well season'd hide.

A hundred other examples might be quoted from this translation; but these will explain our meaning.

There are other occasions on which the delicacy of figurative language is still more needful; as in Virgil's account of the effects of animal love, and of the plague among the beasts, in the third Georgic; where Dryden's style, by being less figurative than the original, is in one place exceedingly filthy, and in another shockingly obscene.

Hobbes could construe a Greek author; but his skill in words must have been all derived from the dictionary: for he seems not to have known that any one articulate sound could be more agreeable, or any one phrase more dignified, than another. In his Iliad and Odyssey, even when he hits the author's sense (which is not always the case), he proves, by his choice of words, that of harmony, elegance, or energy of style, he had no manner of conception. And hence that work, though called a *Translation of Homer*, does not even deserve the name of *poem*; because it is in every respect unpleasing, being nothing more than a fictitious narrative delivered in a mean prose, with the additional meanness of harsh rhyme, and untuneable measure.——Trapp understood Virgil well enough as a grammarian, and had a taste for his beauties: yet his translation bears no resemblance to Virgil; which is owing to the same cause, an imprudent choice of words and figures, and a total want of harmony.

55 Whi… howe… may… ried t…

The delicacy we here contend for, may indeed, both in conversation and in writing, be carried too far. To call *killing an innocent man in a duel* an affair of honour, and *a violation of the rights of wedlock* an affair of gallantry, is a prostitution of figurative language. Nor is it any credit to us, that we are said to have upwards of 40 figurative phrases to denote excessive drinking. Language of this sort generally implies, that the public abhorrence of such crimes is not so strong as it ought to be; and it is a question, whether even our morals might not be improved, if we were to call these and such like crimes by their proper names, *murder*, *adultery*, *drunkenness*, *gluttony*; names, that not only express our meaning, but also betoken our disapprobation.——As to writing, it cannot be denied, that even Pope himself, in the excellent version just now quoted, has sometimes, for the sake of his numbers, or for fear of giving offence by too close an imitation of Homer's simplicity, employed tropes and figures too quaint or too solemn for the occasion. And the finical style is in part characterised by the writer's dislike to literal expressions, and affectedly substituting in their stead unnecessary tropes and figures. With these authors, a man's only child must always be his *only hope*; a country maid becomes *a rural beauty*, or perhaps a *nymph of the groves*; if flattery sing at all, it must be a *syren song*; the shepherd's flute dwindles into an *oaten reed*, and his crook is exalted into a *sceptre*; the *silver lilies* rise from their *golden beds*, and *languish* to the *complaining* gale. A young woman, though a good Christian, cannot make herself agreeable without *sacrificing to the Graces*; nor hope

* Odyss. b. 14. v. 41.

opes Fi-

hope to do any execution among the *gentle ſwains*, till a whole legion of *Cupids*, armed with *flames* and *darts*, and other weapons, begin to diſcharge from her eyes their formidable artillery. For the ſake of variety, or of the verſe, ſome of theſe figures may now and then find a place in a poem; but in proſe, unleſs very ſparingly uſed, they ſavour of affectation.

and pro- pre- nd

(3.) Tropes and figures promote brevity; and brevity, united with perſpicuity, is always agreeable. An example or two will be given in the next paragraph. Sentiments thus delivered, and imagery thus painted, are readily apprehended by the mind, make a ſtrong impreſſion upon the fancy, and remain long in the memory; whereas too many words, even when the meaning is good, never fail to bring diſguſt and wearineſs. They argue a debility of mind which hinders the author from ſeeing his thoughts in one diſtinct point of view; and they alſo encourage a ſuſpicion, that there is ſomething faulty or defective in the matter. In the poetic ſtyle, therefore, which is addreſſed to the fancy and paſſions, and intended to make a vivid, a pleaſing, and a permanent impreſſion, brevity, and conſequently tropes and figures, are indiſpenſable. And a language will always be the better ſuited to poetical purpoſes, the more it admits of this brevity;—a character which is more conſpicuous in the Greek and Latin than in any modern tongue, and much leſs in the French than in the Italian or Engliſh.

7 ibute ngth ergy guage.

(4.) Tropes and figures contribute to ſtrength or energy of language, not only by their conciſeneſs, but alſo by conveying to the fancy ideas that are eaſily comprehended, and make a ſtrong impreſſion. We are powerfully affected with what we ſee, or feel, or hear. When a ſentiment comes enforced or illuſtrated by figures taken from objects of ſight, or touch, or hearing, one thinks, as it were, that one ſees, or feels, or hears, the thing ſpoken of; and thus, what in itſelf would perhaps be obſcure, or is merely intellectual, may be made to ſeize our attention and intereſt our paſſions almoſt as effectually as if it were an object of outward ſenſe. When Virgil calls the Scipios *thunderbolts of war*, he very ſtrongly expreſſes in one word, and by one image, the rapidity of their victories, the noiſe their atchievements made in the world, and the ruin and conſternation that attended their irreſiſtible career.——When Homer calls Ajax *the bulwark of the Greeks*, he paints with equal brevity his vaſt ſize and ſtrength, the difficulty of prevailing againſt him, and the confidence wherewith his countrymen repoſed on his valour. ——When Solomon ſays of the ſtrange woman, or harlot, that "her feet go *down* to death," he lets us know, not only that her path ends in deſtruction, but alſo, that they who accompany her will find it eaſy to go forwards to ruin, and difficult to return to their duty.——Satan's enormous magnitude, and refulgent appearance, his perpendicular aſcent through a region of darkneſs, and the inconceivable rapidity of his motion, are all painted out to our fancy by Milton, in one very ſhort ſimilitude,

> Sprung upward, like—a pyramid of fire.
> *Par. Loſt*, b. 4. v. 1013.

To take in the full meaning of which figure, we muſt imagine ourſelves in chaos, and a vaſt luminous body riſing upward, near the place where we are, ſo ſwiftly as to appear a continued track of light, and leſſening to the view according to the increaſe of diſtance, till it end in a point, and then diſappear; and all this muſt be ſuppoſed to ſtrike our eye at one inſtant.——Equal to this in propriety, though not in magnificence, is that allegory of Gray, — Of Tropes and Figures.

> The paths of glory lead but to the grave:

Which preſents to the imagination a wide plain, where ſeveral roads appear, crowded with glittering multitudes, and iſſuing from different quarters, but drawing nearer and nearer as they advance, till they terminate in the dark and narrow houſe, where all their glories enter in ſucceſſion, and diſappear for ever.——When it is ſaid in Scripture, of a good man who died, that he *fell aſleep*, what a number of ideas are at once conveyed to our imagination, by this beautiful and expreſſive figure: As a labourer, at the cloſe of day, goes to ſleep, with the ſatisfaction of having performed his work, and with the agreeable hope of awaking in the morning of a new day, refreſhed and cheerful; ſo a good man, at the end of life, reſigns himſelf calm and contented to the will of his Maker, with the ſweet reflection of having endeavoured to do his duty, and with the tranſporting hope of ſoon awaking in the regions of light, to life and happineſs eternal. The figure alſo ſuggeſts, that to a good man the tranſition from life to death is, even in the ſenſation, no more painful, than when our faculties melt away into the pleaſing inſenſibility of ſleep.——Satan, flying among the ſtars, is ſaid by Milton to "*ſail* between worlds and worlds;" which has an elegance and force far ſuperior to the proper word *fly*. For by this alluſion to a ſhip, we are made to form a lively idea of his great ſize, and to conceive of his motion, that it was equable and majeſtic.——Virgil uſes a happy figure to expreſs the ſize of the great wooden horſe, by means of which the Greeks were conveyed into Troy: "Equum divina Palladis arte *ædificant*."——Milton is ſtill bolder when he ſays,

> Who would not ſing for Lycidas? he knew
> Himſelf to ſing, and *build the lofty rhyme*.

The phraſe, however, though bold, is emphatical; and gives a noble idea of the durability of poetry, as well as of the art and attention requiſite to form a good poem.——There are hundreds of tropical expreſſions in common uſe, incomparably more energetic than any proper words of equal brevity that could be put in their place. A cheek *burning* with bluſhes, is a trope which at once deſcribes the colour as it appears to the beholder, and the glowing heat as it is felt by the perſon bluſhing. *Chilled* with deſpondence, *petrified* with aſtoniſhment, *thunderſtruck* with diſagreeable and unexpected intelligence, *melted* with love or pity, *diſſolved* in luxury, *hardened* in wickedneſs, *ſoftening* into remorſe, *inflamed* with deſire, *toſſed* with uncertainty, &c.—every one is ſenſible of the force of theſe and the like phraſes, and that they muſt contribute to the energy of compoſition.

58 They are likewiſe the language of ſtrong paſſion.

(5.) Tropes and figures promote ſtrength of expreſſion; and are in poetry peculiarly requiſite, becauſe they are often more *natural*, and more *imitative*, than proper words. In fact, this is ſo much the caſe, that it would be impoſſible to imitate the language of paſſion without them. It is true, that when the mind is agitated, one does not run out into allegories, or long-winded ſimilitudes, or any of the figures that require much attention and

Of Tropes and Figures.

and many words, or that tend to withdraw the fancy from the object of the passion. Yet the language of many passions must be figurative notwithstanding; because they rouse the fancy, and direct it to objects congenial to their own nature, which diversify the language of the speaker with a multitude of allusions. The fancy of a very angry man, for example, presents to his view a train of disagreeable ideas connected with the passion of anger, and tending to encourage it; and if he speak without restraint during the paroxysm of his rage, those ideas will force themselves upon him, and compel him to give them utterance. "Infernal monster! (he will say),—my blood boils at him; he has used me like a dog; never was man so injured as I have been by this barbarian. He has no more sense of propriety than a stone. His countenance is diabolical, and his soul as ugly as his countenance. His heart is cold and hard, and his resolutions dark and bloody," &c. This speech is wholly figurative. It is made up of *metaphors* and *hyperboles*, which, with the *prosopopeia* and *apostrophe*, are the most passionate of all the figures. Lear, driven out of doors by his unnatural daughters, in the midst of darkness, thunder, and tempest, naturally breaks forth (for his indignation is just now raised to the very highest pitch) into the following violent exclamation against the crimes of mankind, in which almost every word is figurative.

Tremble, thou wretch,
That hast within thee undivulged crimes
Unwhipt of justice. Hide thee, thou bloody hand,
Thou perjur'd, and thou simular of virtue,
That art incestuous. Caitiff, to pieces shake,
That under covert, and convenient seeming,
Hast practis'd on man's life. Close pent-up guilts,
Rive your concealing continents, and cry
These dreadful summoners grace. *King Lear.*

——The vehemence of maternal love, and sorrow from the apprehension of losing her child, make the Lady Constance utter a language that is strongly figurative, though quite suitable to the condition and character of the speaker. The passage is too long for a quotation, but concludes thus:

O Lord! my boy, my Arthur, my fair son,
My life, my joy, my food, my all the world,
My widow-comfort, and my sorrow's cure. *King John.*

——Similar to this, and equally expressive of conjugal love, is that beautiful hyperbole in Homer; where Andromache, to dissuade her husband from going out to the battle, tells him that she had now no mother, father, or brethren, all her kindred being dead, and her native country desolate; and then tenderly adds,

But while my Hector yet survives, I see
My father, mother, brethren, all in thee. *Iliad*, b. 6.

59
The simplest language most suitable to depressing passions.

As the passions that agitate the soul, and rouse the fancy, are apt to vent themselves in tropes and figures, so those that depress the mind adopt for the most part a plain diction without any ornament: for to a dejected mind, wherein the imagination is generally inactive, it is not probable that any great variety of ideas will present themselves; and when these are few and familiar, the words that express them must be simple. As no author equals Shakespeare in boldness or variety of figures when he copies the style of those violent passions that stimulate the fancy; so, when he would exhibit the human mind in a dejected state, no uninspired writer excels him in simplicity. The same Lear whose resentment had impaired his understanding, while it broke out in the most boisterous language, when, after some medical applications, he recovers his reason, his rage being now exhausted, his pride humbled, and his spirits totally depressed, speaks in a style than which nothing can be imagined more simple or more affecting.

Pray, do not mock me:
I am a very foolish, fond old man,
Fourscore and upward; and, to deal plainly with you,
I fear I am not in my perfect mind.
Methinks I should know you, and know this man;
Yet I am doubtful: for I am mainly ignorant
What place this is; and all the skill I have
Remembers not these garments: nor I know not
Where I did lodge last night.——*Lear*, act 4. sc. 7.

——Desdemona, ever gentle, artless, and sincere, shocked at the unkindness of her husband, and overcome with melancholy, speaks in a style so beautifully simple, and so perfectly natural, that one knows not what to say in commendation of it:

My mother had a maid call'd Barbara;
She was in love, and he she lov'd prov'd mad,
And did forsake her. She had a song of willow;
An old thing it was, but it express'd her fortune,
And she died singing it. That song to-night
Will not go from my mind: I have much to do,
But to go hang my head all at one side,
And sing it like poor Barbara. *Othello*, act 4. sc. 3.

6[illegible]
And [illegible] sentim[illegible] of a [illegible]tion.

Sometimes the imagination, even when exerted to the utmost, takes in but few ideas. This happens when the attention is totally engrossed by some very great object; admiration being one of those emotions that rather suspend the exercise of the faculties than push them into action. And here, too, the simplest language is the most natural; as when Milton says of the Deity, that he sits "high-throned above all height." And as this simplicity is more suitable to that one great exertion which occupies the speaker's mind than a more elaborate imagery or language would have been, so has it also a more powerful effect in fixing and elevating the imagination of the hearer; for to introduce other thoughts for the sake of illustrating what cannot be illustrated, could answer no other purpose than to draw off the attention from the principle idea. In these and the like cases, the fancy left to itself will have more satisfaction in pursuing at leisure its own speculations than in attending to those of others; as they who see for the first time some admirable object would choose rather to feast upon it in silence, than to have their thoughts interrupted by a long description from another person, informing them of nothing but what they see before them, are already acquainted with, or may easily conceive.

It was remarked above, that the *hyperbole*, *prosopopeia*, and *apostrophe*, are among the most passionate figures. This deserves illustration.

6[illegible]
Hy[illegible] natur[illegible]

1*st*, A very angry man is apt to think the injury he has just received greater than it really is; and if he proceed immediately to retaliate by word or deed, seldom [illegible] fails to exceed the due bounds, and to become injurious [illegible] in [illegible]

Tropes and Figures.

in his turn. The fond parent looks upon his child as a prodigy of genius and beauty; and the romantic lover will not be perſuaded that his miſtreſs has nothing ſupernatural either in her mind or perſon. Fear, in like manner, not only magnifies its object when real, but even forms an object out of nothing, and miſtakes the fictions of fancy for the intimations of ſenſe.—No wonder, then, that they who ſpeak according to the impulſe of paſſion ſhould ſpeak *hyperbolically;* that the angry man ſhould exaggerate the injury he has received, and the vengeance he is going to inflict; that the ſorrowful ſhould magnify what they have loſt, and the joyful what they have obtained; that the lover ſhould ſpeak extravagantly of the beauty of his miſtreſs, the coward of the dangers he has encountered, and the credulous clown of the miracles performed by the juggler. In fact, theſe people would not do juſtice to what they feel if they did not ſay more than the truth. The valiant man, on the other hand, as naturally adopts the diminiſhing hyperbole when he ſpeaks of danger; and the man of ſenſe, when he is obliged to mention his own virtue or ability; becauſe it appears to him, or he is willing to conſider it, as leſs than the truth, or at beſt as inconſiderable. Contempt uſes the ſame figure; and therefore Petruchio, affecting that paſſion, affects alſo the language of it:

Thou lieſt, thou thread, thou thimble,
Thou yard, three-quarters, half-yard, quarter, nail,
Thou flea, thou nit, thou winter-cricket, thou!
Brav'd in mine own houſe with a ſkein of thread!
Away, thou rag, thou quantity, thou remnant!

Taming of the Shrew, act 4. ſc. 1.

For ſome paſſions conſider their objects as important, and others as unimportant. Of the former ſort are anger, love, fear, admiration, joy, ſorrow, pride; of the latter are contempt and courage. Thoſe may be ſaid to ſubdue the mind to the object, and theſe to ſubdue the object to the mind. And the former, when violent, always magnify their objects; whence the hyperbole called amplification, or *auxeſis:* and the latter as conſtantly diminiſh theirs; and give riſe to the hyperbole called *meioſis,* or diminution.—Even when the mind cannot be ſaid to be under the influence of any violent paſſion, we naturally employ the ſame figure when we would impreſs another very ſtrongly with any idea. "He is a walking ſhadow; he is worn to ſkin and bone; he has one foot in the grave and the other following:"—theſe, and the like phraſes, are proved to be natural by their frequency. By introducing great ideas, the hyperbole is further uſeful in poetry as a ſource of the ſublime; but when employed injudiciouſly is very apt to become ridiculous. Cowley makes Goliah as big as the hill down which he was marching †; and tells us, that when he came into the valley he ſeemed to fill it, and to overtop the neighbouring mountains (which, by the by, ſeems rather to leſſen the mountains and valleys than to magnify the giant); nay, he adds, that the ſun ſtarted back when he ſaw the ſplendour of his arms. This poet ſeems to have thought that the figure in queſtion could never be ſufficiently enormous; but Quintilian would have taught him, "Quamvis omnis hyperbole ultra fidem, non tamen eſſe debet ultra modum." The reaſon is, that this figure, when exceſſive, betokens rather abſolute infatuation than intenſe emotion; and reſembles the efforts of a ranting tragedian, or the ravings of an enthuſiaſtic declaimer, who, by putting on the geſtures and looks of a lunatic, ſatisfy the diſcerning part of their audience, that, inſtead of feeling ſtrongly, they have no rational feelings at all. In the wildeſt energies of nature there is a modeſty which the imitative artiſt will be careful never to overſtep.

ideis,

62

Proſopopœia when proper.

2dly, That figure, by which things are ſpoken of as if they were perſons, is called *proſopopœia,* or *perſonification.* It is a bold figure, and yet is often natural. Long acquaintance recommends to ſome ſhare in our affection even things inanimate, as a houſe, a tree, a rock, a mountain, a country; and were we to leave ſuch a thing, without hope of return, we ſhould be inclined to addreſs it with a farewel, as if it were a percipient creature. Hence it was that Mary queen of Scotland, when on her return to her own kingdom, ſo affectionately bade adieu to the country which ſhe had left. "Farewel, France," ſaid ſhe; "farewel, beloved country, which I ſhall never more behold!" Nay, we find that ignorant nations have actually worſhipped ſuch things, or conſidered them as the haunt of certain powerful beings. Dryads and hamadryads were by the Greeks and Romans ſuppoſed to preſide over trees and groves; river gods and nymphs, over ſtreams and fountains; little deities, called *Lares* and *Penates,* were believed to be the guardians of hearths and houſes. In Scotland there is hardly a hill remarkable for the beauty of its ſhape, that was not in former times thought to be the habitation of fairies. Nay, modern as well as ancient ſuperſtition has appropriated the waters to a peculiar ſort of demon or goblin, and peopled the very regions of death, the tombs and charnel-houſes, with multitudes of ghoſts and phantoms.—Beſides, when things inanimate make a ſtrong impreſſion upon us, whether argeeable or otherwiſe, we are apt to addreſs them in terms of affection or diſlike. The ſailor bleſſes the plank that brought him aſhore from the ſhipwreck; and the paſſionate man, and ſometimes even the philoſopher, will ſay bitter words to the ſtumbling-block that gave him a fall.—Moreover, a man agitated with any intereſting paſſion, eſpecially of long continuance, is apt to fancy that all nature ſympathiſes with him. If he has loſt a beloved friend, he thinks the ſun leſs bright than at other times; and in the ſighing of the winds and groves, in the lowings of the herd, and in the murmurs of the ſtream, he ſeems to hear the voice of lamentation. But when joy or hope predominate, the whole world aſſumes a gay appearance. In the contemplation of every part of nature, of every condition of mankind, of every form of human ſociety, the benevolent and the pious man, the moroſe and the cheerful, the miſer and the miſanthrope, finds occaſion to indulge his favourite paſſion, and ſees, or thinks he ſees, his own temper reflected back in the actions, ſympathies, and tendencies of other things and perſons. Our affections are indeed the medium through which we may be ſaid to ſurvey ourſelves, and every thing elſe; and whatever be our inward frame, we are apt to perceive a wonderful congeniality in the world without us. And hence the fancy, when rouſed by real emotions, or by the pathos of compoſition, is eaſily reconciled to thoſe figures of ſpeech that aſcribe ſympathy, perception, and the other attributes of animal life, to things inanimate, or even to notions merely intellectual.—Motion, too, bears a cloſe affinity

Of Tropes and Figures.

affinity to action, and affects our imagination nearly in the same manner; and we see a great part of nature in motion, and by its sensible effects are led to contemplate energies innumerable. These conduct the rational mind to the Great First Cause; and these, in times of ignorance, disposed the vulgar to believe in a variety of subordinate agents employed in producing those appearances that could not otherwise be accounted for. Hence an endless train of fabulous deities, and of witches, demons, fairies, genii; which, if they prove our reason weak and our fancy strong, prove also that personification is natural to the human mind; and that a right use of this figure may have a powerful effect, in fabulous writing especially, to engage our sympathy in behalf of things as well as persons: for nothing can give lasting delight to a moral being, but that which awakens sympathy, and touches the heart; and though it be true that we sympathise in some degree even with inanimate things, yet what has, or is supposed to have, life, calls forth a more sincere and more permanent fellow-feeling. —Let it be observed further, that to awaken our sympathetic feelings, a lively conception of their object is necessary. This indeed is true of almost all our emotions; their keenness is in proportion to the vivacity of the perceptions that excite them. Distress that we see is more affecting than what we only hear of *; a perusal of the gayest scenes in a comedy does not rouse the mind so effectually as the presence of a cheerful companion; and the death of a friend is of greater energy in producing seriousness, and the consideration of our latter end, than all the pathos of Young. Of descriptions addressed to the fancy, those that are most vivid and picturesque will generally be found to have the most powerful influence over our affections; and those that exhibit persons engaged in action, and adorned with visible insignia, give a brisker impulse to the faculties than such as convey intellectual ideas only, or images taken from still life. No abstract notion of time, or of love, can be so striking to the fancy as the image of an old man accoutred with a scythe, or of a beautiful boy with wings and a bow and arrows: and no physiological account of frenzy could suggest so vivid an idea as the poet has given us in that exquisite portrait,

* *Hor. Ar. Poet.* v. 180.

And moody madness laughing wild amid severest wo.

And for this reason partly it is that the epic poet, in order to work the more effectually upon our passions and imagination, refers the secret springs of human conduct, and the vicissitudes of human affairs, to the agency of personified causes; that is, to the machinery of gods and goddesses, angels, demons, magicians, and other powerful beings. And hence, in all sublime poetry, life and motion, with their several modes and attributes, are liberally bestowed on those objects wherewith the author intends that we should be strongly impressed: scenes perfectly inanimate and still, tending rather to diffuse a languor over the mind than to communicate to our internal powers those lively energies without which a being essentially active can never receive complete gratification.—Lastly, some violent passions are peculiarly inclined to change things into persons. The horrors of his mind haunted Orestes in the shape of furies. Conscience, in the form of the murdered person, stares the murderer in the face, and often terrifies him to distraction. The superstitious man, travelling alone in the dark, mistakes a white stone for a ghost, a bush for a demon, a tree waving with the wind for an enormous giant brandishing a hundred arms. The lunatic and enthusiast converse with persons who exist only in their own distempered fancy; and the glutton and the miser, if they were to give utterance to all their thoughts, would often, it is presumable, speak, the one of his gold, the other of his belly, not only as a person, but as a god,—the object of his warmest love and most devout regard.—More need not be said to prove that personification is natural, and may frequently contribute to the pathos, energy, and beauty of poetic language.

6 Apostrophe how to be used.

3dly, *Apostrophe*, or a sudden diversion of speech from one person to another person or thing, is a figure nearly related to the former. Poets sometimes make use of it, in order to help out their verse, or merely to give variety to their style: but on these occasions it is to be considered as rather a trick of art, than an effort of nature. It is most natural, and most pathetic, when the person or thing to whom the apostrophe is made, and for whose sake we give a new direction to our speech, is in our eyes eminently distinguished for good or evil, or raises within us some sudden and powerful emotion, such as the hearer would acquiesce in, or at least acknowledge to be reasonable. But this, like the other pathetic figures, must be used with great prudence. For if, instead of calling forth the hearer's sympathy, it should only betray the levity of the speaker, or such wanderings of his mind as neither the subject nor the occasion would lead one to expect, it will then create disgust instead of approbation. The orator, therefore, must not attempt the passionate apostrophe, till the minds of the hearers be prepared to join in it. And every audience is not equally obsequious in this respect. In the forum of ancient Rome that would have passed for sublime and pathetic, which in the most respectable British auditories would appear ridiculous. For our style of public speaking is cool and argumentative; and partakes less of enthusiasm than the Roman did, and much less than the modern French or Italian. Of British eloquence, particularly that of the pulpit, the chief recommendations are gravity and simplicity. And it is vain to say, that our oratory *ought* to be more vehement: for that matter depends on causes, which it is not only inexpedient, but impossible to alter; namely, on the character and spirit of the people, and their rational notions in regard to religion, policy, and literature. The exclamations of Cicero would weigh but little in our parliament; and many of those which we meet with in French sermons would not be more effectual if attempted in our pulpit. To see one of our preachers, who the moment before was a cool reasoner, a temperate speaker, an humble Christian, and an orthodox divine, break out into a sudden apostrophe to the immortal powers, or to the walls of the church, tends to force a smile, rather than a tear, from those among us who reflect, that there is nothing in the subject, and should be nothing in the orator, to warrant such wanderings of fancy or vehemence of emotion. If he be careful to cultivate a pure style, and a grave and graceful utterance, a British clergyman, who speaks from conviction the plain unaffected words of truth and soberness, of benevolence and piety, will, it is believed, convey more pathetic, as well as more permanent, impressions to the heart,

heart, and be more useful as a Christian teacher, than if he were to put in practice all the attitudes of Roscius, and all the tropes and figures of Cicero.

But where the language of passion and enthusiasm is permitted to display itself, whatever raises any strong emotion, whether it be animated or inanimate, absent or present, sensible or intellectual, may give rise to the apostrophe. A man in a distant country, speaking of the place of his birth, might naturally exclaim, "O my dear native land, shall I never see thee more!" Or, when some great misfortune befals him, "Happy are ye, O my parents, that ye are not alive to see this." We have a beautiful apostrophe in the third book of the Æneid, where Æneas, who is telling his story to Dido, happening to mention the death of his father, makes a sudden address to him as follows:

——— hic, pelagi tot tempestatibus actus,
Heu, genitorem, omnis curæ casusque levamen,
Amitto Anchisen:—hic me, pater optime, fessum
Deseris, heu, tantis nequicquam erepte periclis!

This apostrophe has a pleasing effect. It seems to intimate, that the love which the hero bore his father was so great, that when he mentioned him he forgot every thing else; and, without minding his company, one of whom was a queen, suddenly addressed himself to that which, though present only in idea, was still a principal object of his affection. An emotion so warm and so reasonable cannot fail to command the sympathy of the reader.——When Michael, in the eleventh book of Paradise Lost, announces to Adam and Eve the necessity of their immediate departure from the garden of Eden, the poet's art in preserving the decorum of the two characters is very remarkable. Pierced to the heart at the thought of leaving that happy place, Eve, in all the violence of ungovernable sorrow, breaks forth into a pathetic apostrophe to Paradise, to the flowers she had reared, and to the nuptial bower she had adorned. Adam makes no address to the walks, the trees, or the flowers of the garden, the loss whereof did not so much afflict him; but, in his reply to the Archangel, expresses, without a figure, his regret for being banished from a place where he had been so oft honoured with a sensible manifestation of the divine presence. The use of the apostrophe in the one case, and the omission of it in the other, not only gives a beautiful variety to the style, but also marks that superior elevation and composure of mind, by which the poet had all along distinguished the character of Adam.—One of the finest applications of this figure that is anywhere to be seen, is in the fourth book of the same poem; where the author, catching by sympathy the devotion of our first parents, suddenly drops his narrative, and joins his voice to theirs in adoring the Father of the universe.

Thus at their shady lodge arriv'd, both stood,
Both turn'd, and under open sky ador'd
The God that made both sky, air, earth, and heav'n,
Which they beheld, the moon's resplendent globe,
And starry pole:—Thou also mad'st the night,
Maker omnipotent! and thou the day,
Which we in our appointed work employ'd
Have finish'd.———

Milton took the hint of this fine contrivance from a well-known passage of Virgil:

Of Tropes and Figures.

Hic juvenum chorus, ille senum; qui carmine laudes
Herculeas et facta ferant;———
——— ut duros mille labores
Rege sub Eurystheo, fatis Junonis iniquæ,
Pertulerit:—Tu nubigenas, invicte, bimembres,
Hylæum Pholoumque, manu; tu Cresia mactas
Prodigia.———

The beauty arising from diversified composition is the same in both, and very great in each. But every reader must *feel*, that the figure is incomparably more affecting to the mind in the imitation than in the original. So true it is, that the most rational emotions raise the most intense fellow-feeling; and that the apostrophe is then the most emphatical, when it displays those workings of human affection which are at once ardent and well-founded.

64 Tropes and figures are useful, as they suggest an endless variety of agreeable images.

To conclude this head: Tropes and figures, particularly the *metaphor*, *similitude*, and *allegory*, are further useful in beautifying language, by suggesting, together with the thoughts essential to the subject, an endless variety of agreeable images, for which there would be no place, if writers were always to confine themselves to the *proper* names of things. And this beauty and variety, judiciously applied, is so far from distracting, that it tends rather to fix, the attention, and captivate the heart of the readers, by giving light, and life, and pathos, to the whole composition.

II. That tropes and figures are more necessary to poetry, than to any other mode of writing, was the second point proposed to be illustrated in this section.

65 Tropes and figures more necessary to poetry than to any other mode of writing.

Language, as already observed, is then natural, when it is suitable to the supposed condition of the speaker. Figurative language is peculiarly suitable to the supposed condition of the poet; because figures are suggested by the fancy; and the fancy of him who composes poetry is more employed than that of any other author. Of all historical, philosophical, and theological researches, the object is *real* truth, which is fixed and permanent. The aim of rhetorical declamation (according to Cicero) is *apparent* truth; which, being less determinate, leaves the fancy of the speaker more free, gives greater scope to the inventive powers, and supplies the materials of a more figurative phraseology. But the poet is subject to no restraints, but those of verisimilitude; which is still less determinate than rhetorical truth. He seeks not to convince the judgment of his reader by arguments of either real or apparent cogency; he means only to please and interest him, by an appeal to his sensibility and imagination. His own imagination is therefore continually at work, ranging through the whole of real and probable existence, "glancing from heaven to earth, from earth to heaven," in quest of images and ideas suited to the emotions he himself feels, and to the sympathies he would communicate to others. And, consequently, figures of speech, the offspring of excursive fancy, must (if he speak according to what he is supposed to think and feel, that is, according to his supposed condition) tincture the language of the poet more than that of any other composer. So that, if figurative diction be unnatural in geometry, because all wanderings of fancy are unsuitable, and even impossible, to the geometrician, while intent upon his argument; it is, upon the same principle, perfectly

Of Tropes and Figures.

fectly natural, and even unavoidable, in poetry; becaufe the more a poet attends to his fubject, and the better qualified he is to do it juftice, the more active will his imagination be, and the more diverfified the ideas that prefent themfelves to his mind. —— Befides, the true poet addreffes himfelf to the paffions and fympathies of mankind; which, till his own be raifed, he cannot hope to do with fuccefs. And it is the nature of many paffions, though not of all, to increafe the activity of imagination: and an active imagination naturally vents itfelf in figurative language; nay, unlefs reftrained by a correct tafte, has a tendency to exceed in it; of which Bifhop Taylor and Lord Verulam, two geniufes different in kind, but of the higheft order, are memorable examples.

We faid, that "the poet feeks not to convince the judgment of his reader by arguments of either real or apparent cogency."——We do not mean, that in poetry argument has no place. The moft legitimate reafoning, the foundeft philofophy, and narratives purely hiftorical, may appear in a poem, and contribute greatly to the honour of the author, and to the importance of his work. All this we have in Paradife Loft. We mean, that what diftinguifhes *pure* poetry from other writing, is its aptitude, not to fway the judgment by reafoning, but to pleafe the fancy, and move the paffions, by a lively imitation of nature. Nor would we exclude poetical embellifhment from hiftory, or even from philofophy. Plato's Dialogues and the Moral Effays of Addifon and Johnfon abound in poetic imagery; and Livy and Tacitus often amufe their readers with poetical defcription. In like manner, though geometry and phyfics be different fciences; though abftract ideas be the fubject, and pure demonftration or intuition the evidence, of the former; and though the material univerfe, and the informations of fenfe, be the fubject and the evidence of the latter; yet have thefe fciences been united by the beft philofophers, and very happy effects refulted from the union. —— In one and the fame work, poetry, hiftory, philofophy, and oratory, may doubtlefs be blended; nay, thefe arts have all been actually blended in one and the fame work, not by Milton only, but alfo by Homer, Virgil, Lucan, and Shakefpeare. Yet ftill thefe arts are different; different in their ends and principles, and in the faculties of the mind to which they are refpectively addreffed: and it is eafy to perceive when a writer employs one and when another.

§ 2. *Of the* Sound *of Poetical Language.*

66 The poet ought to attend to the harmony of language, which confifts in

As the ear, like every other perceptive faculty, is capable of gratification, regard is to be had to the found of words, even in profe. But to the harmony of language, it behoves the poet, more than any other writer, to attend; as it is more efpecially his concern to render his work pleafurable. In fact, we find, that no poet was ever popular who did not poffefs the art of harmonious compofition.

What belongs to the fubject of Poetical Harmony may be referred to one or other of thefe heads, *Sweetnefs*, *Meafure*, and *Imitation*.

Of Poetical Harmony.

6[?] Sweetness and

I. In order to give *fweetnefs* to language, either in verfe or profe, all words of harfh found, difficult pronunciation, or unwieldy magnitude, are to be avoided as much as poffible, unlefs when they have in the found fomething peculiarly emphatical; and words are to be fo placed in refpect of one another, as that difcordant combinations may not refult from their union. But in poetry this is more neceffary than in profe; poetical language being underftood to be an imitation of natural language improved to that perfection which is confiftent with probability. To poetry, therefore, a greater latitude muft be allowed than to profe, in expreffing, by tropes and figures of pleafing found, thofe ideas whereof the proper names are in any refpect offenfive, either to the ear or to the fancy.

II. How far verfification or *regular meafure* may be effential to this art, has been difputed by critical writers; fome holding it to be indifpenfably neceffary, and fome not neceffary at all.

6[?] Meafure, which, though not effential,

The fact feems to be, as already hinted, that to poetry verfe is not effential. In a profe work, we may have the fable, the arrangement, and a great deal of the pathos and language, of poetry; and fuch a work is certainly a poem, though perhaps not a perfect one. For how abfurd would it be to fay, that by changing the pofition only of a word or two in each line, one might diveft Homer's Iliad of the poetical character! At this rate, the arts of poetry and verfification would be the fame; and the rules in Defpauter's Grammar, and the moral diftichs afcribed to Cato, would be as real poetry as any part of Virgil. In fact, fome very ancient poems, when tranflated into a modern tongue, are far lefs poetical in verfe than in profe; the alterations neceffary to adapt them to our numbers being detrimental to their fublime fimplicity; of which any perfon of tafte will be fenfible, who compares our common profe-verfion of Job, the Pfalms, and the Song of Solomon, with the beft metrical paraphrafe of thofe books that has yet appeared. Nay, in many cafes, Comedy will be more poetical, becaufe more pleafing and natural, in profe than in verfe. By verfifying Tom Jones, and The Merry Wives of Windfor, we fhould fpoil the two fineft comic poems, the one epic, the other dramatical, now in the world.

6[?] Adds to the perfection of poetry.

But, fecondly, though verfe be not effential to poetry, it is neceffary to the perfection of all poetry that admits of it. Verfe is to poetry, what colours are to painting (G). A painter might difplay great genius, and draw mafterly figures with chalk or ink; but if he intend a perfect picture, he muft employ in his work as many colours as are feen in the object he imitates. Or, to adopt a beautiful comparifon of Demofthenes, quoted by Ariftotle *, "Verfification is to poetry what bloom is to the human countenance." A good face is agreeable when the bloom is gone, and good poetry may pleafe without verfification; harmonious numbers may fet

* Rhet. lib. 3. cap. 4.

(G) Horace feems to hint at the fame comparifon, when, after fpecifying the feveral forts of verfe fuitable to Epic, Elegiac, Lyric, and Dramatic Poetry, he adds,

Defcriptas fervare vices, *operumque colores.*
Cur ego, fi nequeo ignoroque, Poeta falutor? *Ar. Poet.* ver. 86.

etical ony

ſet off an indifferent poem, and a fine bloom indifferent features: but, without verſe, poetry is incomplete; and beauty is not perfect, unleſs to ſweetneſs and regularity of feature there be ſuperadded,

The bloom of young deſire, and purple light of love.

If numbers are neceſſary to the perfection of the higher poetry, they are no leſs ſo to that of the lower kinds, to Paſtoral, Song, and Satire, which have little beſides the language and verſification to diſtinguiſh them from proſe; and which ſome ancient authors are unwilling to admit to the rank of poems: though it ſeems too nice a ſcruple, both becauſe ſuch writings are commonly termed *poetical;* and alſo becauſe there is, even in them, ſomething that may not improperly be conſidered as an imitation of nature.

That the rhythm and meaſures of verſe are naturally agreeable, and therefore that by theſe poetry may be made more pleaſing than it would be without them, is evident from this, that children and illiterate people, whoſe admiration we cannot ſuppoſe to be the effect of habit or prejudice, are exceedingly delighted with them. In many proverbial ſayings, where there is neither rhime nor alliteration, rhythm is obviouſly ſtudied. Nay, the uſe of rhythm in poetry is univerſal; whereas alliteration and rhime, though reliſhed by ſome nations, are not much ſought after by others. And we need not be at a loſs to account for the agreeableneſs of proportion and order, if we reflect, that they ſuggeſt the agreeable ideas of contrivance and ſkill, at the ſame time that they render the connection of things obvious to the underſtanding, and imprint it deeply on the memory. Verſe, by promoting diſtinct and eaſy remembrance, conveys ideas to the mind with energy, and enlivens every emotion the poet intends to raiſe in the reader or hearer. Beſides, when we attend to verſes, after hearing one or two, we become acquainted with the meaſure, which therefore we always look for in the ſequel. This perpetual interchange of hope and gratification is a ſource of delight; and to this in part is owing the pleaſure we take in the rhimes of modern poetry. And hence we ſee, that though an incorrect rhime or untuneable verſe be in itſelf, and compared with an important ſentiment, a very trifling matter; yet it is no trifle in regard to its effects on the hearer; becauſe it brings diſappointment, and ſo gives a temporary ſhock to the mind, and interrupts the current of the affections; and becauſe it ſuggeſts the diſagreeable ideas of negligence or want of ſkill on the part of the author. And therefore, as the public ear becomes more delicate, the negligence will be more glaring, and the diſappointment more intenſely felt; and correctneſs of rhime and of meaſure will of courſe be the more indiſpenſable. In our tongue, rhime is more neceſſary to Lyric than to Heroic poetry. The reaſon ſeems to be, that in the latter the ear can of itſelf per-

70 hat rhime be dif- d in En- poe-

ceive the boundary of the meaſure, becauſe the lines are all of equal length nearly, and every good reader makes a ſhort pauſe at the end of each; whereas, in the former, the lines vary in length: and therefore the rhime is requiſite to make the meaſure and rhythm ſufficiently perceptible. Cuſtom too may have ſome influence. Engliſh Odes without rhime are uncommon; and therefore have ſomething aukward about them, or ſomething at leaſt to which the public ear is not yet thoroughly reconciled. Indeed, when the drama is excepted, we do not think that rhime can be ſafely ſpared from Engliſh poetry of any kind, but when the ſubject is able to ſupport itſelf. "He that thinks himſelf capable of aſtoniſhing (ſays Johnſon) may write blank verſe; but thoſe that hope only to pleaſe, muſt condeſcend to rhime."

Of Poetical Harmony.

Rhime, however, is of leſs importance by far than rhythm, which in poetry as well as in muſic is the ſource of much pleaſing variety; of variety tempered with uniformity, and regulated by art; inſomuch that, notwithſtanding the likeneſs of one hexameter verſe to another, it is not common, either in Virgil or in Homer, to meet with two contiguous hexameters whoſe rhythm is exactly the ſame. And though all Engliſh heroic verſes conſiſt of five feet, among which the iambic predominates; yet this meaſure, in reſpect of rhythm alone, is ſuſceptible of more than 30 varieties. And let it be remarked further, that different kinds of verſe, by being adapted to different ſubjects and modes of writing, give variety to the poetic language, and multiply the charms of this pleaſing art.

71 The language of the epic poet muſt be elevated and his numbers uniformly majeſtic.

What has formerly been ſhown to be true in regard to ſtyle, will alſo in many caſes hold true of verſification, "that it is then *natural*, when it is adapted to the *ſuppoſed condition* of the ſpeaker."—In the epopee, the poet aſſumes the character of calm inſpiration; and therefore his language muſt be elevated, and his numbers majeſtic and uniform. A peaſant ſpeaking in heroic or hexameter verſe is no improbability here; becauſe his words are ſuppoſed to be tranſmitted by one who will of his own accord give them every ornament neceſſary to reduce them into dignified meaſure; as an eloquent man, in a ſolemn aſſembly, recapitulating the ſpeech of a clown, would naturally expreſs it in pure and perſpicuous language. The uniform heroic meaſure will ſuit any ſubject of dignity, whether narrative or didactic, that admits or requires uniformity of ſtyle. In tragedy, where the imitation of real life is more perfect than in epic poetry, the uniform magnificence of epic numbers might be improper; becauſe the heroes and heroines are ſuppoſed to ſpeak in their own perſons, and according to the immediate impulſe of paſſion and ſentiment.

72 In tragedy the ſame uniform magnificence would be improper, and much more ſo in comedy.

Yet, even in tragedy, the verſification may be both harmonious and dignified; becauſe the characters are taken chiefly from high life, and the events from a remote period; and becauſe the higher poetry is permitted to imitate nature, not as it is, but in that ſtate of perfection in which it might be. The Greeks and Romans conſidered their hexameter as too artificial for dramatic poetry; and therefore in tragedy, and even in comedy, made uſe of the iambic, and ſome other meaſures that came near the cadence of converſation: we uſe the iambic both in the epic and dramatic poem; but for the moſt part it is, or ought to be, much more elaborate in the former than in the latter. In dramatic comedy, where the manners and concerns of familiar life are exhibited, verſe would ſeem to be unnatural, except it be ſo like the ſound of common diſcourſe as to be hardly diſtinguiſhable from it. Cuſtom, however, may in ſome countries determine otherwiſe; and againſt cuſtom, in theſe matters, it is vain to argue. The profeſſed enthuſiaſm of the dithyrambic poet renders wildneſs, variety, and a ſonorous harmony of numbers, peculiarly ſuitable to his odes. The love-ſonnet, and Anacreontic ſong, will be leſs various, more regular,

Of Poetical Harmony.

lar, and of a ſofter harmony; becauſe the ſtate of mind expreſſed in it has more compoſure. Philoſophy can ſcarce go further in this inveſtigation, without deviating into whim and hypotheſis. The particular ſorts of verſe to be adopted in the lower ſpecies of poetry, are determined by faſhion chiefly, and the practice of approved authors.

III. The origin and principles of *imitative harmony*, or of that artifice by which the ſound is made, as Pope ſays, "an echo to the ſenſe," may be explained in the following manner.

73
A ſtriking analogy between moral and material beauty and deformity.

It is pleaſing to obſerve the uniformity of nature in all her operations. Between moral and material beauty and harmony, between moral and material deformity and diſſonance, there obtains a very ſtriking analogy. The viſible and audible expreſſions of almoſt every virtuous emotion are agreeable to the eye and the ear, and thoſe of almoſt every criminal paſſion diſagreeable. The looks, the attitudes, and the vocal ſounds, natural to benevolence, to gratitude, to compaſſion, to piety, are in themſelves graceful and pleaſing; while anger, diſcontent, deſpair, and cruelty, bring diſcord to the voice, deformity to the features, and diſtortion to the limbs. That flowing curve, which painters know to be eſſential to the beauty of animal ſhape, gives place to a multiplicity of right lines and ſharp angles in the countenance and geſture of him who knits his brows, ſtretches his noſtrils, grinds his teeth, and clenches his fiſt; whereas, devotion, magnanimity, benevolence, contentment, and good-humour, ſoften the attitude, and give a more graceful ſwell to the outline of every feature. Certain vocal tones accompany certain mental emotions. The voice of ſorrow is feeble and broken, that of deſpair boiſterous and incoherent; joy aſſumes a ſweet and ſprightly note, fear a weak and tremulous cadence; the tones of love and benevolence are muſical and uniform, thoſe of rage loud and diſſonant; the voice of the ſedate reaſoner is equable and grave, but not unpleaſant; and he who declaims with energy, employs many varieties of modulation ſuited to the various emotions that predominate in his diſcourſe.

But it is not in the language of paſſion only that the human voice varies its tone, or the human face its features. Every ſtriking ſentiment, and every intereſting idea, has an effect upon it. One would eſteem that perſon no adept in narrative eloquence, who ſhould deſcribe, with the very ſame accent, ſwift and ſlow motion, extreme labour and eaſy performance, agreeable ſenſation and excruciating pain; who ſhould talk of the tumult of a tempeſtuous ocean, the roar of thunder, the devaſtations of an earthquake, or an Egyptian pyramid tumbling into ruins, in the ſame tone of voice wherewith he deſcribes the murmur of a rill, the warbling of the harp of Æolus, the ſwinging of a cradle, or the deſcent of an angel. Elevation of mind gives dignity to the voice. From Achilles, Sarpedon, and Othello, we ſhould as naturally expect a manly and ſonorous accent, as a nervous ſtyle and majeſtic attitude. Coxcombs and bullies, while they aſſume airs of importance and valour, affect alſo a dignified articulation.

74
The ſo[...] of imit[...] harmo[...] numbe[...]

Since the tones of natural language are ſo various, poetry, which imitates the language of nature, muſt alſo vary its tones; and, in reſpect of ſound as well as of meaning, be framed after that model of ideal perfection, which the variety and energy of the human articulate voice render probable. This is the more eaſily accompliſhed, becauſe in every language there is between the ſound and ſenſe of certain words a perceptible analogy; which, though not ſo accurate as to lead a foreigner from the ſound to the ſignification, is yet accurate enough to ſhow, that, in forming ſuch words, regard has been had to the imitative qualities of vocal ſound. Such, in Engliſh, are the words *yell*, *craſh*, *crack*, *hiſs*, *roar*, *murmur*, and many others.

All the particular laws that regulate this ſort of imitation, as far as they are founded in nature, and liable to the cognizance of philoſophy, depend on the general law of ſtyle above mentioned. Together with the other circumſtances of the ſuppoſed ſpeaker, the poet takes into conſideration the tone of voice ſuitable to the ideas that occupy his mind, and thereto adapts the ſound of his language, if it can be done conſiſtently with eaſe and elegance of expreſſion. But when this imitative harmony is too much ſought after, or words appear to be choſen for ſound rather than ſenſe, the verſe becomes finical and ridiculous. Such is Ronſard's affected imitation of the ſong of the ſky-lark:

> Elle quindée du zephire
> Sublime en l'air vire et revire,
> Et y declique un joli cris,
> Qui rit, guérit, et tire l'ire
> Des eſprit mieux que je n'écris.

This is as ridiculous as that line of Ennius,

> Tum tuba terribili ſonitu taratantara dixit:

Or as the following verſes of Swift;

> The man with the kettle-drum enters the gate,
> Dub dub a dub dub: the trumpeters follow,
> Tantara tantara; while all the boys hollow.

75
What [...] mony [...] numbe[...] can imi[...]tate.

Words by their ſound may imitate ſound; and quick or ſlow articulation may imitate quick or ſlow motion. Hence, by a proper choice and arrangement of words, the poet may imitate *Sounds* that are ſweet with dignity (H),—ſweet and tender (I),—loud (K),—and harſh

---

(H) No ſooner had th' Almighty ceas'd, than all
The multitude of angels, with a ſhout
Loud as from numbers without number, ſweet
As from bleſt voices uttering joy; heav'n rung
With jubilee, and loud hoſannas fill'd
Th' eternal regions.—— *Par. Loſt*, b. 3.

See alſo the night-ſtorm of thunder, lightning, wind, and rain, in Virg. Georg. lib. 1. ver. 328—334.

(I) Et longum, formoſe, vale, vale, inquit, Iola.
Virg. Ecl. 1.

Formoſam reſonare doces Amarillida ſilvas.
Virg. Ecl. 1.

See alſo the ſimile of the nightingale, Geor. lib. 4. verſ. 511. And ſee that wonderful couplet deſcribing the wailings of the owl, Æneid IV. 462.

(K) ——— ——— vibratus ab æthere fulgor
Cum ſonitu venit, et ruere omnia viſa repente,
Tyrrhenuſque tubæ mugire per æthera clangor,
Suſpiciunt: iterumatque iterumfragor intonat ingens.
Æneid. 8.

See

harsh (L);—and *Motions* that are slow, in consequence of dignity (M),—slow in consequence of difficulty (N), swift and noisy (O)—swift and smooth (P)—uneven and abrupt (Q),—quick and joyous (R). An unexpected pause in the verse may also imitate a sudden failure of strength (S), or interruption of motion (T), or give vivacity to an image or thought, by fixing our attention longer than usual upon the word that precedes it (U).—Moreover, when we describe great bulk, it is natural for us to articulate slowly, even in common discourse; and therefore a line of poetry that requires a slow pronunciation, or seems longer than it should be, may be used with good effect in describing vastness of size (X).—Sweet and smooth numbers are most proper, when the poet paints agreeable objects, or gentle energy (Y); and harsher sounds when he speaks of what is ugly, violent, or disagreeable (Z). This too is according to the nature of common language; for we generally employ harsher tones of voice to express what we dislike, and more melodious notes to describe the objects of love, complacency, or admiration. Harsh numbers, however, should not be frequent in poetry: for

---

See also the storm in the first book of the Æneid, and in the fifth of the Odyssey.

(L) The hoarse rough verse shall like the torrent roar. *Pope.*

——— On a sudden open fly,
With impetuous recoil and jarring sound,
Th' infernal doors, and on their hinges grate
Harsh thunder.—— *Par. Lost*, II. 879.

See also Homer's Iliad, lib. 2. ver. 363. and Clarke's Annotation.

(M) See an exquisite example in Gray's Progress of Poesy; the conclusion of the third stanza.

(N) And when up ten steep slopes you've dragg'd your thighs. *Pope.*

Just brought out this, when scarce his tongue could stir. *Pope.*

————The huge leviathan
Wallowing unwieldy, enormous in their gait,
Tempest the ocean. *Par. Lost*, VII. 411.

See the famous description of Sisyphus rolling the stone, Odyss. lib. 11. ver. 592. See Quintil. Inst. Orat. lib. 9. cap. 4. § 4. compared with Paradise Lost, book 2. ver. 1022.

(O) Quadrupedante putrem sonitu quatit ungula campum. *Æneid.*

Αυταρ επειτα πεδονδε κυλινδετο λαας αναιδης. *Odyss.* 11.

See also Virg. Æneid. lib. 1. ver. 83—87.

(P) See wild as the winds o'er the desert he flies. *Pope.*

Ille volat, simul arva fuga, simul æquora verrens. *Virg.*

Ρειδιν τ' επειτα πελει, χαλεπη περ εουσα. *Hesiod.*

(Q) Πολλα δ' αναντα καταντα παραντα τε δοχμια τ' ηλθον. *Hom.*

The lass shriek'd, started up, and shriek'd again. *Anonym.*

(R) Let the merry bells ring round,
And the jocund rebecks sound,
To many a youth, and many a maid,
Dancing in the chequer'd shade. *Milt. Allegro.*

See also Gray's Progress of Poesy, stanza 3.

(S) Ac velut in somnis oculos ubi languida pressit
Nocte quies, nequicquam avidos extendere cursus
Velle videmur:—et in mediis conatibus ægri
Succidimus.—— *Æneid.*

See also Virg. Georg. lib. 3. ver. 515, 516.

(T) For this, be sure to-night thou shalt have cramps,
Side-stitches that shall pen thy breath up. Urchins
Shall exercise upon thee.——
Prospero to Calyban in *the Tempest.*

See Pope's Iliad, XIII. 199.

(U) ———How often from the steep
Of echoing hill or thicket have we heard
Celestial voices, to the midnight air,
Sole,—or responsive to each other's note,
Singing their great Creator?——*Par. Lost*, b. 4.

And over them triumphant Death his dart
Shook,——but delay'd to strike. *Id.*

See also Hom. Odyss. l. 9. v. 290.

(X) Thus stretch'd out, huge in length, the arch fiend lay. *Par. Lost.*

Monstrum horrendum, informe, ingens, cui lumen ademptum. *Æneid.* 3.

Et magnos membrorum artus, magna ossa, lacertosque
Exuit, atque ingens media consistit arena. *Æneid.* v. 422.

(Y) Hic gelidi fontes, hic mollia prata, Lycori,
Hic nemus, hic ipso tecum consumerer ævo. *Virg. Ecl.* 10.

The dumb shall sing; the lame his crutch forego,
And leap, exulting, like the bounding roe. *Pope's Messiah.*

See Milton's description of the evening, Par. Lost, book 4. ver. 598—609.

Ye gentle gales beneath my body blow,
And softly lay me on the waves below. *Pope's Sappho.*

(Z) Stridenti stipula miserum disperdere carmen. *Virg. Ecl.* 3.

Immo ego Sardois videar tibi amarior herbis,
Horridior rusco, projecta vilior alga. *Virg. Ecl.* 7.

Neu patriæ validas in viscera vertite vires. *Virg. Æneid.* 6.

See also Milton's description of the Lazar-house in Paradise Lost, b. 11. v. 477—492.

Of the Epopee and Drama.

for in this art, as in music, concord and melody ought always to predominate. And we find in fact, that good poets can occasionally express themselves somewhat harshly, when the subject requires it, and yet preserve the sweetness and majesty of poetical diction. Further, the voice of complaint, pity, love, and all the gentler affections, is mild and musical, and should therefore be imitated in musical numbers; while despair, defiance, revenge, and turbulent emotions in general, assume an abrupt and sonorous cadence. Dignity of description (A), solemn vows (B), and all sentiments that proceed from a mind elevated with great ideas (C), require a correspondent pomp of language and versification.— Lastly, an irregular or uncommon movement in the verse may sometimes be of use, to make the reader conceive an image in a particular manner. Virgil, describing horses running over rocky heights at full speed, begins the line with two dactyls, to imitate rapidity, and concludes it with eight long syllables:

Saxa per, et scopulos, et depressas convalles.

Geor. III. 276.

which is a very unusual measure, but seems well adapted to the thing expressed, namely, to the descent of the animal from the hills to the low ground. At any rate, this extraordinary change of the rhythm may be allowed to bear some resemblance to the animal's change of motion, as it would be felt by a rider, and as we may suppose it is felt by the animal itself.

Other forms of imitative harmony, and many other examples, besides those referred to in the margin, will readily occur to all who are conversant in the writings of the best versifiers, particularly Homer, Virgil, Milton, Lucretius, Spenser, Dryden, Shakespeare, Pope, and Gray.

Part II. Of the DIFFERENT SPECIES of POETRY, with their Particular Principles.

Sect. I. *Of Epic and Dramatic Compositions.*

§ 1. *The Epopee and Drama compared.*

Elem. of Criticism. 76

In what tragic and epic poetry agree, and in what they differ.

Tragedy and the epic differ not in substantials: in both the same ends are proposed, viz. instruction and amusement; and in both the same mean is employed, viz. imitation of human actions. They differ only in the manner of imitating: epic poetry employs narration; tragedy represents its facts as passing in our sight: in the former, the poet introduces himself as an historian; in the latter, he presents his actors, and never himself.

This difference, regarding form only, may be thought slight: but the effects it occasions are by no means so; for what we see makes a deeper impression than what we learn from others. A narrative poem is a story told by another: facts and incidents passing upon the stage, come under our own observation; and are beside much enlivened by action and gesture, expressive of many sentiments beyond the reach of language.

A dramatic composition has another property, independent altogether of action; which is, that it makes a deeper impression than narration: in the former, persons express their own sentiments; in the latter, sentiments are related at second-hand. For that reason, Aristotle, the father of critics, lays it down as a rule*, That in an epic poem the author ought to take every opportunity of introducing his actors, and of confining the narrative part within the narrowest bounds. Homer understood perfectly the advantage of this method; and his poems are both of them in a great measure dramatic. Lucan runs to the opposite extreme: and is guilty of a still greater fault, in stuffing his *Pharsalia* with cold and languid reflections, the merit of which he assumes to himself, and deigns not to share with his actors. Nothing can be more injudiciously timed, than a chain of such reflections, which suspend the battle of Pharsalia after the leaders had made their speeches, and the two armies are ready to engage †.

* *Poet.* chap 25. sect. 6.

† *Lib.* from 385 to 460.

Tragic and epic pathetic or moral.

Aristotle, from the nature of the fable, divides tragedy into simple and complex: but it is of greater moment, with respect to dramatic as well as epic poetry, to found a distinction upon the different ends attained by such compositions. A poem, whether dramatic or epic, that has nothing in view but to move the passions and to exhibit pictures of virtue and vice, may be distinguished by the name of *pathetic*: but where a story is purposely contrived to illustrate some moral truth, by showing that disorderly passions naturally lead to external misfortunes, such composition may be denominated *moral*. Beside making a deeper impression than can be done by cool reasoning, a moral poem does not fall short of reasoning in affording conviction: the natural connection of vice with misery, and of virtue with happiness, may be illustrated by stating a fact as well as by urging an argument. Let us assume, for example, the following moral truths: That discord among the chiefs renders ineffectual all common measures; and that the consequences of a slightly-founded quarrel, fostered by pride and arrogance, are not less fatal than those of the grossest injury: these truths may be inculcated by the quarrel between Agamemnon and Achilles at the siege of Troy. If facts or circumstances be wanting, such as tend to rouse the turbulent passions, they must be invented; but no accidental nor unaccountable event ought to be admitted; for the necessary or probable connection between vice and misery is

(A) See Virg. Geor. I. 328. and Homer, Virgil, and Milton, *passim.* See also Dryden's Alexander's Feast, and Gray's Odes.

(B) See Virg. Æneid, IV. 24.

(C) Examples are frequent in the great authors. See Othello's exclamation:

——————— O now for ever
Farewell the tranquil mind! &c. *Act* 3. *sc.* 3.

is not learned from any events but what are naturally occasioned by the characters and passions of the persons represented, acting in such circumstances. A real event, of which we see not the cause, may afford a lesson, upon the presumption that what hath happened may again happen: but this cannot be inferred from a story that is known to be a fiction.

Many are the good effects of such compositions. A pathetic composition, whether epic or dramatic, tends to a habit of virtue, by exciting us to do what is right, and restraining us from what is wrong. Its frequent pictures of human woes produce, beside, two effects, extremely salutary: they improve our sympathy, and fortify us to bear our own misfortunes. A moral composition must obviously produce the same good effects, because by being moral it ceaseth not to be pathetic: it enjoys besides an excellence peculiar to itself; for it not only improves the heart, as above-mentioned, but instructs the head by the moral it contains. It seems impossible to imagine any entertainment more suited to a rational being, than a work thus happily illustrating some moral truth; where a number of persons of different characters are engaged in an important action, some retarding, others promoting, the great catastrophe; and where there is dignity of style as well as of matter. A work of this kind has our sympathy at command, and can put in motion the whole train of the social affections: our curiosity in some scenes is excited, in others gratified; and our delight is consummated at the close, upon finding, from the characters and situations exhibited at the commencement, that every incident down to the final catastrophe is natural, and that the whole in conjunction make a regular chain of causes and effects.

Considering that an epic and a dramatic poem are the same in substance, and have the same aim or end, one will readily imagine, that subjects proper for the one must be equally proper for the other. But considering their difference as to form, there will be found reason to correct that conjecture, at least in some degree. Many subjects may indeed be treated with equal advantage in either form: but the subjects are still more numerous for which they are not equally qualified; and there are subjects proper for the one and not at all for the other. To give some slight notion of the difference, as there is no room here for enlarging upon every article, we observe, that dialogue is better qualified for expressing sentiments, and narrative for displaying facts. Heroism, magnanimity, undaunted courage, and other elevated virtues, figure best in action; tender passions, and the whole tribe of sympathetic affections, figure best in sentiment. It clearly follows, that tender passions are more peculiarly the province of tragedy, grand and heroic actions of epic poetry.

"The epic poem is universally allowed to be*, of all poetical works, the most dignified, and, at the same time, the most difficult in execution. To contrive a story which shall please and interest all readers, by being at once entertaining, important, and instructive; to fill it with suitable incidents; to enliven it with a variety of characters and of descriptions; and, throughout a long work, to maintain that propriety of sentiment, and that elevation of style, which the epic character requires, is unquestionably the highest effort of poetical genius.

Of the Epopee and Drama.

80 The proper subject of an epic poem.

"The action or subject of the epic poem must be great and interesting. Without greatness it would not have sufficient importance either to fix our attention or to justify the magnificent apparatus which the poet bestows on it. This is so evidently requisite as not to require illustration; and, indeed, hardly any who have attempted epic poetry have failed in choosing some subject sufficiently important, either by the nature of the action or by the fame of the personages concerned in it. The fame of Homer's heroes, and the consequences of dissension between the greatest of them, is a subject important in itself, and must have appeared particularly so to his countrymen, who boasted their descent from those heroes. The subject of the Æneid is still greater than that of the Iliad, as it is the foundation of the most powerful empire that ever was established upon this globe; an event of much greater importance than the destruction of a city, or the anger of a semibarbarous warrior. But the poems of Homer and Virgil fall in this respect infinitely short of that of Milton. 'Before the greatness displayed in Paradise Lost, it has been well observed § that all other greatness shrinks away. The subject of the English poet is not the destruction of a city, the conduct of a colony, or the foundation of an empire: it is the fate of worlds, the revolutions of heaven and earth; rebellion against the Supreme King, raised by the highest order of created beings; the overthrow of their host, and the punishment of their crime; the creation of a new race of reasonable creatures; their original happiness and innocence, their forfeiture of immortality, and their restoration to hope and peace."

§ *Johnson's Life of Milton.*

An epic poem, however, is defective if its action be not interesting as well as great; for a narrative of mere valour may be so constructed as to prove cold and tiresome. "Much * will depend on the happy choice of some subject, which shall by its nature interest the public; as when the poet selects for his hero one who is the founder, or the deliverer, or the favourite of his nation; or when he writes atchievements that have been highly celebrated, or have been connected with important consequences to any public cause. Most of the great epic poems are abundantly fortunate in this respect, and must have been very interesting to those ages in which they were composed." The subject of the Paradise Lost, as it is infinitely greater, must likewise be considered as more universally interesting than that of any other poem. "We all feel the effects of Adam's transgression; we all sin like him, and like him must all bewail our offences. We have restless and insidious enemies in the fallen angels, and in the blessed spirits we have guardians and friends; in the redemption of mankind we hope to be included; in the description of heaven and hell we are surely interested, as we are all to reside hereafter either in the regions of horror or bliss."

* *Blair ubi supra.*

81 Circumstances chiefly interesting in epic poetry.

"The chief circumstance which renders an epic poem interesting †, and which tends to interest not one age or country alone, but all readers, is the skilful conduct of the author in the management of his subject. His plan must comprehend many affecting incidents. He may sometimes be awful and august; he must often be tender and pathetic; he must give us gentle and pleasing scenes of love, friendship, and affection. The more that an epic poem abounds with situations which awaken

† *Blair and Johnson.*

Of the Epopee and Drama.

awaken the feelings of humanity, it is the more interesting. In this respect perhaps no epic poets have been so happy as Virgil and Tasso. The plan of the *Paradise Lost* comprises neither human actions nor human manners. The man and woman who act and suffer, are in a state which no other man or woman can ever know. The reader finds no transaction in which he can be engaged; beholds no condition in which he can by any effort of imagination place himself; he has therefore little natural curiosity or sympathy."

82
Whether the hero must necessarily be successful.

A question has been moved, Whether the nature of the epic poem does not require that the hero should be ultimately successful? To this question Johnson replies, that "there is no reason why the hero should not be unfortunate, except established practice, since success and virtue do not necessarily go together." Most critics, however, are of a different opinion, and hold success to be, if not the necessary, at least the most proper issue of an epic poem. An unhappy conclusion depresses the mind, and is opposite to the elevating emotions which belong to this species of poetry. Terror and compassion are the proper subjects of tragedy; but as the epic is of larger extent, it were too much, if, after the difficulties and troubles which commonly abound in the progress of the poem, the author should bring them all at last to an unfortunate conclusion. We know not that any author of name has held this course except *Lucan;* for in the *Paradise Lost*, as Adam's deceiver is at last crushed, and he himself restored to the favour of his maker, Milton's hero must be considered as finally successful.

83
Different kinds of dramatic poetry.

We have no occasion to say more of the epic, considered as peculiarly adapted to certain subjects, and to be conducted according to a certain plan. But as dramatic subjects are more complex, it is necessary to take a narrower view of them. They are either the light and the gay, or the grave and affecting, incidents of human life. The former constitute the subject of comedy, and the latter of tragedy.

As great and serious objects command more attention than little and ludicrous ones; as the fall of a hero interests the public more than the marriage of a private person; tragedy has been always held a more dignified entertainment than comedy. The first thing required of the tragic poet is, that he pitch upon some moving and interesting story, and that he conduct it in a natural and probable manner. For we must observe, that the natural and probable are more essential to tragic than even to epic poetry. Admiration is excited by the wonderful; but passion can be raised only by the impressions of nature and truth upon the mind.

84
Subjects best suited to tragedy.

The subject best fitted for tragedy is where a man has himself been the cause of his misfortune; not so as to be deeply guilty, nor altogether innocent: the misfortune must be occasioned by a fault incident to human nature, and therefore in some degree venial. Such misfortunes call forth the social affections, and warmly interest the spectator. An accidental misfortune, if not extremely singular, doth not greatly move our pity: the person who suffers, being innocent, is freed from the greatest of all torments, that anguish of mind which is occasioned by remorse. An atrocious criminal, on the other hand, who brings misfortunes upon himself, excites little pity, for a different reason: his remorse, it is true, aggravates his distress, and swells the first emotions of pity; but then our hatred of him as a criminal blending with pity, blunts its edge considerably. Misfortunes that are not innocent, nor highly criminal, partake the advantages of each extreme: they are attended with remorse to embitter the distress, which raises our pity to a great height; and the slight indignation we have at a venial fault detracts not sensibly from our pity. The happiest of all subjects accordingly for raising pity, is where a man of integrity falls into a great misfortune by doing an action that is innocent, but which, by some singular means, is conceived by him to be criminal: his remorse aggravates his distress; and our compassion, unrestrained by indignation, knows no bounds. Pity comes thus to be the ruling passion of a pathetic tragedy; and, by proper representation, may be raised to a height scarce exceeded by any thing felt in real life. A moral tragedy takes in a larger field; as it not only exercises our pity, but raises another passion, which, though selfish, deserves to be cherished equally with the social affection. The passion we have in view is fear or terror; for when a misfortune is the natural consequence of some wrong bias in the temper, every spectator who is conscious of such a bias in himself takes the alarm, and dreads his falling into the same misfortune: and by the emotion of fear or terror, frequently reiterated in a variety of moral tragedies, the spectators are put upon their guard against the disorders of passion.

The commentators upon Aristotle, and other critics, have been much gravelled about the account given of tragedy by that author: "That by means of pity and terror, it refines or purifies in us all sorts of passion." But no one who has a clear conception of the end and effects of a good tragedy, can have any difficulty about Aristotle's meaning: Our pity is engaged for the persons represented; and our terror is upon our own account. Pity indeed is here made to stand for all the sympathetic emotions, because of these it is the capital. There can be no doubt, that our sympathetic emotions are refined or improved by daily exercise; and in what manner our other passions are refined by terror, has been just now said. One thing is certain, that no other meaning can justly be given to the foregoing doctrine than that now mentioned; and that it was really Aristotle's meaning, appears from his 13th chapter, where he delivers several propositions conformable to the doctrine as here explained. These, at the same time, we take liberty to mention; because, so far as authority can go, they confirm the foregoing reasoning about subjects proper for tragedy. The first proposition is, That it being the province of tragedy to excite pity and terror, an innocent person falling into adversity ought never to be the subject. This proposition is a necessary consequence of his doctrine as explained: a subject of that nature may indeed excite pity and terror; but the former in an inferior degree, and the latter in no degree for moral instruction. The second proposition is, That the history of a wicked person in a change from misery to happiness ought not to be represented; which excites neither terror nor compassion, nor is agreeable in any respect. The third is, That the misfortunes of a wicked person ought not to be represented: such representation may be agreeable in some measure

the e and ma. meaſure upon a principle of juſtice; but it will not move our pity; nor any degree of terror, except in thoſe of the ſame vicious diſpoſition with the perſon repreſented. The laſt propoſition is, That the only character fit for repreſentation lies in the middle, neither eminently good nor eminently bad; where the misfortune is not the effect of deliberate vice, but of ſome involuntary fault, as our author expreſſes it. The only objection we find to Ariſtotle's account of tragedy, is, that he confines it within too narrow bounds, by refuſing admittance to the pathetic kind: for if terror be eſſential to tragedy, no repreſentation deſerves that name but the moral kind, where the misfortunes exhibited are cauſed by a wrong balance of mind, or ſome diſorder in the internal conſtitution: ſuch misfortunes always ſuggeſt moral inſtruction; and by ſuch misfortunes only can terror be excited for our improvement.

Thus Ariſtotle's four propoſitions above-mentioned relate ſolely to tragedies of the moral kind. Thoſe of the pathetic kind are not confined within ſo narrow limits: ſubjects fitted for the theatre are not in ſuch plenty as to make us reject innocent misfortunes which rouſe our ſympathy, though they inculcate no moral. With reſpect indeed to the ſubjects of that kind, it may be doubted, whether the concluſion ought not always to be fortunate. Where a perſon of integrity is repreſented as ſuffering to the end under misfortunes purely accidental, we depart diſcontented, and with ſome obſcure ſenſe of injuſtice: for ſeldom is man ſo ſubmiſſive to Providence, as not to revolt againſt the tyranny and vexations of blind chance; he will be tempted to ſay, this ought not to be. We give for an example the *Romeo and Juliet* of Shakeſpeare, where the fatal cataſtrophe is occaſioned by Friar Laurence's coming to the monument a minute too late; we are vexed at the unlucky chance, and go away diſſatisfied. Such impreſſions, which ought not to be cheriſhed, are a ſufficient reaſon for excluding ſtories of this kind from the theatre.

85
impro- uſe of iny in ancient edies.

The misfortunes of a virtuous perſon, ariſing from neceſſary cauſes, or a chain of unavoidable circumſtances, as they excite a notion of deſtiny, are equally unſatisfactory to the human mind. A metaphyſician in his cloſet may reaſon himſelf into the belief of fate, or what in modern language is called *philoſophical neceſſity*; but the feelings of the heart revolt againſt that doctrine; and we have the confeſſion of the two ableſt philoſophers by whom it was ever maintained, that men conduct themſelves through life as if their will were abſolutely free, and their actions no part of a chain of neceſſary cauſes and effects. As no man goes to the theatre to ſtudy metaphyſics, or to diveſt himſelf of the common feelings of humanity, it is impoſſible, whatever be his philoſophical creed, that he ſhould contemplate without horror and diſguſt an innocent perſon ſuffering by mere deſtiny. A tragedy of uncommon merit in every other reſpect may indeed be endured, nay perhaps admired, though ſuch be its cataſtrophe; becauſe no work of man was ever perfect; and becauſe, where imperfections are unavoidable, a multitude of excellencies may be allowed to cover one fault: but we believe the miſery of an innocent perſon reſulting from a chain of unavoidable circumſtances has never been conſidered as a beauty by minds unperverted by a falſe philoſophy. "It muſt be acknowledged * that the ſubjects of the ancient Greek

Blair.

tragedies were frequently founded on mere deſtiny and inevitable misfortunes. In the courſe of the drama many moral ſentiments occurred; but the only inſtruction which the fable conveyed was, that reverence was due to the gods, and ſubmiſſion to the decrees of fate. Modern tragedy has aimed at a higher object, by becoming more the theatre of paſſion; pointing out to men the conſequences of their own miſconduct, ſhowing the direful effects which ambition, jealouſy, love, reſentment, and other ſuch ſtrong emotions, when miſguided or left unreſtrained, produce upon human life. An Othello, hurried by jealouſy to murder his innocent wife; a Jaffier enſnared by reſentment and want to engage in a conſpiracy, and then ſtung with remorſe and involved in ruin; a Siffredi, through the deceit which he employs for public-ſpirited ends, bringing deſtruction on all whom he loved: theſe, and ſuch as theſe, are the examples which Tragedy now diſplays to public view; and by means of which it inculcates on men the proper government of their paſſions."

Of the Epopee and Drama.

86
How it is uſed in the tragedy of the Robbers.

There is indeed one ſingular drama, in which deſtiny is employed in a manner very different from that in which it was uſed by the poets of Greece and Rome. It is Schiller's Tragedy of the Robbers, of which "the hero, endowed by nature (as the tranſlator of the piece obſerves) with the moſt generous feelings, animated by the higheſt ſenſe of honour, and ſuſceptible of the warmeſt affections of the heart, is driven by the perfidy of a brother, and the ſuppoſed inhumanity of his father, into a ſtate of confirmed miſanthropy and deſpair." He wiſhes that he "could blow the trumpet of rebellion through all nature; that he could extinguiſh with one mortal blow the viperous race of men; and that he could ſo ſtrike as to deſtroy the germ of exiſtence." In this ſituation he is hurried on to the perpetration of a ſeries of crimes, which find from their very magnitude and atrocity a recommendation to his diſtempered mind. Senſible all the while of his own guilt, and ſuffering for that guilt the ſevereſt pangs of remorſe, he yet believes himſelf an inſtrument of vengeance in the hand of the Almighty for the puniſhment of the crimes of others. In thus accompliſhing the dreadful deſtiny which is preſcribed for him, he feels a ſpecies of gloomy ſatisfaction, at the ſame time that he conſiders himſelf as doomed to the performance of that part in life which is to conſign his memory to infamy and his ſoul to perdition. After burning a town, he exclaims, "O God of vengeance! am I to blame for this? Art thou to blame, O Father of Heaven! when the inſtruments of thy wrath, the peſtilence, flood, and famine overwhelm at once the righteous and the guilty? Who can command the flames to ſtay their courſe, to deſtroy only the noxious vermin, and ſpare the fertile field?" yet with the ſame breath he accuſes himſelf of extreme criminality for "preſumptuouſly wielding the ſword of the Moſt High!" He frequently laments in the moſt affecting manner the loſs of his innocence, wiſhes that "he could return into the womb that bare him, that he hung an infant at the breaſt, that he were born a beggar, the meaneſt hind, a peaſant of the field." He conſiders himſelf as the outcaſt of Heaven, and finally rejected by the Father of mercy; yet he tells the band of robbers whom he commanded, that the "Almighty honoured them as agents in his hands to execute his wonderous purpoſes; employed them as his angels to execute his ſtern decrees, and pour the vials of

Of the Epopee and Drama

of his wrath;" and in a very ſolemn prayer, he ſuppoſes that "the God who ruleth over all had *decreed* that he ſhould become the chief of theſe foul murderers."

"It will be allowed, ſays the tranſlator, that the imagination could not have conceived a ſpectacle more deeply intereſting, more powerfully affecting to the mind of man, than that of a human being thus characteriſed and acting under ſuch impreſſions. The compaſſionate intereſt which the mind feels in the emotions or ſufferings of the guilty perſon, is not diminiſhed by the obſervation, that he acts under an impreſſion of inevitable deſtiny; on the contrary, there is ſomething in our nature which leads us the more to compaſſionate the inſtrument of thoſe crimes, that we ſee him conſider himſelf as bound to guilt by fetters, which he has the conſtant wiſh, but not the ſtrength, to break."

This is indeed true: we ſympathiſe with the hero of the Robbers, not only on account of his exalted ſentiments and his inflexible regard to the abſtract principles of honour and juſtice, but much more for that diſorder of intellect which makes him *ſuppoſe* "his deſtiny fixed and unalterable," at the very time that he is torn with remorſe for the perpetration of thoſe crimes by which he believed it to be fulfilling. Deſtiny, however, is not in this tragedy exhibited as real, but merely as the phantom of a diſtempered though noble mind. Had the poet repreſented his hero as in *fact decreed by God*, or *bound by fate*, to head a band of foul murderers, and to commit a ſeries of the moſt atrocious crimes; though our pity for him might not have been leſſened, the impreſſions of the whole piece on the mind could have been only thoſe of horror and diſguſt at what would have appeared to us the unequal ways of providence.

87
Whether the ſubject of tragedy ſhould have its foundation in truth.

The Tragedy of the Robbers is a ſtriking inſtance of the juſtneſs of Dr Blair's criticiſm, in oppoſition to that of Lord Kames. His lordſhip holds that it is eſſential to a good tragedy, that its principal facts be borrowed from hiſtory; becauſe a mixture of known truth with the fable tends to delude us into a conviction of the reality of the whole. The Doctor conſiders this as a matter of no great conſequence; for "it is proved by experience, that a fictitious tale, if properly conducted, will melt the heart as much as any real hiſtory;" this obſervation is verified in the Robbers. It is indeed a very irregular drama, and perhaps could not be acted on a Britiſh theatre. But although the whole is known to be a fiction, we believe there are few effuſions of human genius which more powerfully excite the emotions of terror and pity. Truth is indeed congenial to the mind; and when a ſubject proper for tragedy occurs in hiſtory or tradition, it is perhaps better to adopt it than to invent one which has no ſuch foundation. But in chooſing a ſubject which makes a figure in hiſtory, greater precaution is neceſſary than where the whole is a fiction. In the latter caſe, the author is under no reſtraint other than that the characters and incidents be juſt copies of nature. But where the ſtory is founded on truth, no circumſtances muſt be added, but ſuch as connect naturally with what are known to be true; hiſtory may be ſupplied, but muſt not be contradicted. Further, the ſubject choſen muſt be diſtant in time, or at leaſt in place; for the familiarity of recent perſons and events ought to be avoided. Familiarity ought more eſpecially to be avoided in an epic poem, the peculiar character of which is dignity and elevation: modern manners make but a poor figure in ſuch a poem. Their familiarity unqualifies them for a lofty ſubject. The dignity of them will be better underſtood in future ages, when they are no longer familiar.

After Voltaire, no writer, it is probable, will think of rearing an epic poem upon a recent event in the hiſtory of his own country. But an event of that kind is perhaps not altogether unqualified for tragedy: it was admitted in Greece; and Shakeſpeare has employed it ſucceſsfully in ſeveral of his pieces. One advantage it poſſeſſes above fiction, that of more readily engaging our belief, which tends above any other particular to raiſe our ſympathy. The ſcene of comedy is generally laid at home: familiarity is no objection; and we are peculiarly ſenſible of the ridicule of our own manners.

88
How tragedy ſhould be divided to acts, how many acts it ſhould have.
Elem. Critic. ch. 22

After a proper ſubject is choſen, the dividing it into parts requires ſome art. The concluſion of a book in an epic poem, or of an act in a play, cannot be altogether arbitrary; nor be intended for ſo ſlight a purpoſe as to make the parts of equal length. The ſuppoſed pauſe at the end of every book, and the real pauſe at the end of every act, ought always to coincide with ſome pauſe in the action. In this reſpect, a dramatic or epic poem ought to reſemble a ſentence or period in language, divided into members that are diſtinguiſhed from each other by proper pauſes; or it ought to reſemble a piece of muſic, having a full cloſe at the end, preceded by imperfect cloſes that contribute to the melody. The diviſion of every play into *five* acts has no other foundation than common practice, and the authority of Horace (D). It is a diviſion purely arbitrary; there is nothing in the nature of the compoſition which fixes this number rather than any other; and it had been much better if no ſuch number had been aſcertained. But, ſince it is aſcertained, every act in a dramatic poem ought to cloſe with ſome incident that makes a pauſe in the action; for otherwiſe there can be no pretext for interrupting the repreſentation. It would be abſurd to break off in the very heat of action; againſt which every one would exclaim: the abſurdity ſtill remains where the action relents, if it be not actually ſuſpended for ſome time. This rule is alſo applicable to an epic poem: though in it a deviation from the rule is leſs remarkable; becauſe it is in the reader's power to hide the abſurdity, by proceeding inſtantly to another book. The firſt book of Paradiſe Loſt ends without any cloſe, perfect or imperfect: it breaks off abruptly, where Satan, ſeated on his throne, is prepared to harangue the convocated hoſt of the fallen angels; and the ſecond book begins with the ſpeech. Milton ſeems to have copied the Æneid, of which the two firſt books are divided much in the ſame

(D) *Neve minor, neu ſit quinto productior actu*
Fabula. De Arte Poetica.

If you would have your play deſerve ſucceſs,
Give it five acts complete, nor more nor leſs. *Francis.*

ſame manner. Neither is there any proper pauſe at the end of the ſeventh book of Paradiſe Loſt, nor at the end of the eleventh. In the Iliad little attention is given to this rule.

Beſides tragedy, dramatic poetry comprehends comedy and farce. Theſe are ſufficiently diſtinguiſhed from tragedy by their general ſpirit and ſtrain. "While pity and terror, and the other ſtrong paſſions, form the province of the tragic muſe, the chief or rather ſole inſtrument of comedy and farce is ridicule." Theſe two ſpecies of compoſition are ſo perpetually running into each other, that we ſhall not treat of them ſeparately; ſince what is now known by the name of *farce* differs in nothing eſſential from what was called the *old comedy* among the Greeks. "Comedy propoſes for its object ‡ neither the great ſufferings nor the great crimes of men; but their follies and ſlighter vices, thoſe parts of their character which raiſe in beholders a ſenſe of impropriety, which expoſe them to be cenſured and laughed at by others, or which render them troubleſome in civil ſociety.

"The ſubjects of tragedy are not limited to any age or country; but the ſcene and ſubject of comedy ſhould always be laid in our own country, and in our own times. The reaſon is obvious: thoſe decorums of behaviour, thoſe leſſer diſcriminations of character, which afford ſubject for comedy, change with the differences of countries and times; and can never be ſo well underſtood by foreigners as by natives. The comic poet, who aims at correcting improprieties and follies of behaviour, ſhould 'catch the manners living as they riſe.' It is not his buſineſs to amuſe us with a tale of other times; but to give us pictures taken from among ourſelves; to ſatirize reigning and preſent vices; to exhibit to the age a faithful copy of itſelf, with its humours, its follies, and its extravagancies.

"Comedy may be divided into two kinds: comedy of *character*, and comedy of *intrigue*. The former is the more valuable ſpecies; becauſe it is the buſineſs of comedy to exhibit the prevailing manners which mark the character of the age in which the ſcene is laid: yet there ſhould be always as much intrigue as to give us ſomething to wiſh and ſomething to fear. The incidents ſhould ſo ſucceed one another, as to produce ſtriking ſituations, and to fix our attention; while they afford at the ſame time a proper field for the exhibition of character. The action in comedy, though it demands the poet's care in order to render it animated and natural, is a leſs ſignificant and important part of the performance than the action in tragedy: as in comedy it is what men ſay, and how they behave, that draws our attention, rather than what they perform or what they ſuffer.

"In the management of characters, one of the moſt common faults of comic writers is the carrying of them too far beyond life. Wherever ridicule is concerned, it is indeed extremely difficult to hit the preciſe point where true wit ends and buffoonery begins. When the miſer in Plautus, ſearching the perſon whom he ſuſpects of having ſtolen his caſket, after examining firſt his right hand and then his left, cries out, *oſtende etiam tertiam*— 'ſhow me your third hand,' there is no one but muſt be ſenſible of the extravagance. Certain degrees of exaggeration are allowed to the comedian, but there are limits ſet to it by nature and good taſte; and ſuppoſing the miſer to be ever ſo much engroſſed by his jealouſy and his ſuſpicions, it is impoſſible to conceive any man in his wits ſuſpecting another of having more than two hands." Of the Epopee.

It appears from the plays of Ariſtophanes which remain, that the characters in the old comedy of Athens were almoſt always overcharged. They were likewiſe direct and avowed ſatires againſt particular perſons, who were brought upon the ſtage by name. "The ridicule employed in them is extravagant, the wit for the moſt part buffooniſh and farcical, the raillery biting and cruel, and the obſcenity that reigns in them is groſs and intolerable. They ſeem to have been compoſed merely for the mob." Yet of theſe abominable dramas, an excellent critic * has affirmed, with too much truth, that what is now called *farce* is nothing more than the ſhadow. The characters in genuine comedy are not thoſe of particular and known perſons, but the general characters of the age and nation; which it requires no ſmall ſkill to diſtinguiſh clearly and naturally from each other. In attempting this, poets are too apt to contraſt characters and introduce them always in pairs; which gives an affected air to the whole piece. The perfection of art is to conceal art. "A maſterly writer will give us his characters diſtinguiſhed rather by ſuch ſhades of diverſity as are commonly found in ſociety, than marked with ſuch ſtrong oppoſitions as are rarely brought into actual contraſt in any of the circumſtances of real life."

* Hurd.

92 The ſtyle of comedy.

The ſtyle of comedy ought to be pure, elegant, and lively, very ſeldom riſing higher than the ordinary tone of polite converſation; and upon no occaſion deſcending into vulgar, mean, and groſs expreſſions; and in one word, action and character being the fundamental parts of every epic and dramatic compoſition, the ſentiments and tone of language ought to be ſubſervient to theſe, ſo as to appear natural and proper for the occaſion.

§ 2. *Reſpective peculiarities of the Epopee and Drama.*

93 Machinery can have no place in a drama, nor

In a theatrical entertainment, which employs both the eye and the ear, it would be a groſs abſurdity to introduce upon the ſtage ſuperior beings in a viſible ſhape. There is no place for ſuch objection in an *epic poem*; and Boileau, with many other critics, declares ſtrongly for that ſort of machinery in an epic poem. But waving authority, which is apt to impoſe upon the judgement, let us draw what light we can from reaſon. We may in the firſt place obſerve, that this matter is but indiſtinctly handled by critics: the poetical privilege of animating inſenſible objects for enlivening a deſcription, is very different from what is termed *machinery*, where deities, angels, devils, or other ſupernatural powers, are introduced as real perſonages, mixing in the action, and contributing to the cataſtrophe; and yet theſe two things are conſtantly jumbled together in reaſoning. The former is founded on a natural principle: but nothing is more unnatural than the latter. Its effects, at the ſame time, are deplorable. Firſt, it gives an air of fiction to the whole; and prevents that impreſſion of reality which is requiſite to intereſt our affections, and to move our paſſions; which of itſelf is ſufficient to explode machinery, whatever entertainment it may afford to readers of a fantaſtic taſte or irregular imagination. And, next, were it poſſible, by diſguiſing the fiction, to delude us into a notion of reality, an inſuperable objection would ſtill remain, which is, that the aim or end of

94 Has it a good effect in the higher epic.

an

Of the Epopee.

an epic poem can never be attained in any perfection where machinery is introduced; for an evident reason, that virtuous emotions cannot be raifed fuccefsfully but by the actions of thofe who are endued with paffions and affections like our own, that is, by human actions; and as for moral inftruction, it is clear, that none can be drawn from beings who act not upon the fame principles with us. A fable in Æfop's manner is no objection to this reafoning: his lions, bulls, and goats, are truly men under difguife; they act and feel in every refpect as human beings; and the moral we draw is founded on that fuppofition. Homer, it is true, introduces the gods into his fable: but the religion of his country authorifed that liberty; it being an article in the Grecian creed, that the gods often interpofe vifibly and bodily in human affairs. It muft however be obferved, that Homer's deities do no honour to his poems; fictions that trangrefs the bounds of nature, feldom have a good effect; they may inflame the imagination for a moment, but will not be relifhed by any perfon of a correct tafte. They may be of fome ufe to the lower rank of writers; but an author of genius has much finer materials, of Nature's production, for elevating his fubject, and making it interefting.

One would be apt to think, that Boileau, declaring for the Heathen deities, intended them only for embellifhing the diction: but unluckily he banifhes angels and devils, who undoubtedly make a figure in poetic language, equal to the Heathen deities. Boileau, therefore, by pleading for the latter in oppofition to the former, certainly meant, if he had any diftinct meaning, that the Heathen deities may be introduced as actors. And, in fact, he himfelf is guilty of that glaring abfurdity, where it is not fo pardonable as in an epic poem: In his ode upon the taking of Namur, he demands with a moft ferious countenance, whether the walls were built by Apollo or Neptune: and in relating the paffage of the Rhine, *anno* 1672, he defcribes the god of that river as fighting with all his might to oppofe the French monarch; which is confounding fiction with reality at a ftrange rate. The French writers in general run into this error: wonderful the effect of cuftom, entirely to hide from them how ridiculous fuch fictions are.

That this is a capital error in *Gierufalemme Liberata*, Taffo's greateft admirers muft acknowledge: a fituation can never be intricate, nor the reader ever in pain about the cataftrophe, fo long as there is an angel, devil, or magician, to lend a helping hand. Voltaire, in his effay upon epic poetry, talking of the *Pharfalia*, obferves judicioufly, "That the proximity of time, the notoriety of events, the character of the age, enlightened and political, joined with the folidity of Lucan's fubject, deprived him of poetical fiction." Is it not amazing, that a critic who reafons fo juftly with refpect to others, can be fo blind with refpect to himfelf? Voltaire, not fatisfied to enrich his language with images drawn from invifible and fuperior beings, introduces them into the action: in the fixth canto of the *Henriade* St Louis appears in perfon, and terrifies the foldiers; in the feventh canto, St Louis fends the god of Sleep to Henry; and, in the tenth, the demons of Difcord, Fanaticifm, War, &c. affift Aumale in a fingle combat with Turenne, and are driven away by a good angel brandifhing the fword of God. To blend fuch fictitious perfonages in the fame action with mortals, makes a bad figure at any rate; and is intolerable in a hiftory fo recent as that of Henry IV. But perfection is not the lot of man.

But perhaps the moft fuccefsful weapon that can be employed upon this fubject is ridicule. Addifon has applied this in an elegant manner: "Whereas the time of a general peace is, in all appearance, drawing near; being informed that there are feveral ingenious perfons who intend to fhow their talents on fo happy an occafion, and being willing, as much as in me lies, to prevent that effufion of nonfenfe which we have good caufe to apprehend; I do hereby ftrictly require every perfon who fhall write on this fubject, to remember that he is a Chriftian, and not to facrifice his catechifm to his poetry. In order to it, I do expect of him, in the firft place, to make his own poem, without depending upon Phœbus for any part of it, or calling out for aid upon any of the Mufes by name. I do likewife pofitively forbid the fending of Mercury with any particular meffage or difpatch relating to the peace; and fhall by no means fuffer Minerva to take upon her the fhape of any plenipotentiary concerned in this great work. I do further declare, that I fhall not allow the Deftinies to have had a hand in the deaths of the feveral thoufands who have been flain in the late war; being of opinion that all fuch deaths may be well accounted for by the Chriftian fyftem of powder and ball. I do therefore ftrictly forbid the Fates to cut the thread of man's life upon any pretence whatfoever, unlefs it be for the fake of rhyme. And whereas I have good reafon to fear, that Neptune will have a great deal of bufinefs on his hands in feveral poems which we may now fuppofe are upon the anvil, I do alfo prohibit his appearance, unlefs it be done in metaphor, fimile, or any very fhort allufion; and that even here he may not be permitted to enter, but with great caution and circumfpection. I defire that the fame rule may be extended to his whole fraternity of Heathen gods; it being my defign to condemn every poem to the flames in which Jupiter thunders, or exercifes any other act of authority which does not belong to him. In fhort, I expect that no Pagan agent fhall be introduced, or any fact related which a man cannot give credit to with a good confcience. Provided always, that nothing herein contained fhall extend, or be conftrued to extend, to feveral of the female poets in this nation, who fhall ftill be left in full poffeffion of their gods and goddeffes, in the fame manner as if this paper had never been written." *Spect.* n° 523.

The marvellous is indeed fo much promoted by machinery, that it is not wonderful to find it embraced by the bulk of writers, and perhaps of readers. If indulged at all, it is generally indulged to excefs. Homer introduceth his deities with no greater ceremony than his mortals; and Virgil has ftill lefs moderation: a pilot fpent with watching cannot fall afleep and drop into the fea by natural means: one bed cannot receive the two lovers Æneas and Dido, without the immediate interpofition of fuperior powers. The ridiculous in fuch fictions muft appear even through the thickeft veil of gravity and folemnity.

Angels and devils ferve equally with Heathen deities as materials for figurative language; perhaps better among Chriftians, becaufe we believe in them, and not

in

in Heathen deities. But every one is ſenſible, as well as Boileau, that the inviſible powers in our creed make a much worſe figure as actors in a modern poem than the inviſible powers in the Heathen creed did in ancient poems; the cauſe of which is not far to ſeek. The Heathen deities, in the opinion of their votaries, were beings elevated one ſtep only above mankind, ſubject to the ſame paſſions, and directed by the ſame motives; therefore not altogether improper to mix with men in an important action. In our creed, ſuperior beings are placed at ſuch a mighty diſtance from us, and are of a nature ſo different, that with no propriety can we appear with them upon the ſame ſtage: man, a creature much inferior, loſes all dignity in the compariſon.

There can be no doubt that an hiſtorical poem admits the embelliſhment of allegory as well as of metaphor, ſimile, or other figure. Moral truth, in particular, is finely illuſtrated in the allegorical manner: it amuſes the fancy to find abſtract terms, by a ſort of magic, metamorphoſed into active beings; and it is delightful to trace a general propoſition in a pictured event. But allegorical beings ſhould be confined within their own ſphere, and never be admitted to mix in the principal action, nor to co-operate in retarding or advancing the cataſtrophe; which would have a ſtill worſe effect than inviſible powers: for the impreſſion of real exiſtence, eſſential to an epic poem, is inconſiſtent with that figurative exiſtence which is eſſential to an allegory; and therefore no method can more effectually prevent the impreſſion of reality than the introduction of allegorical beings co-operating with thoſe whom we conceive to be really exiſting. The love-epiſode in the Henriade (canto 9.), inſufferable by the diſcordant mixture of allegory with real life, is copied from that of Rinaldo and Armida in the *Gieruſalemme Liberata*, which hath no merit to intitle it to be copied. An allegorical object, ſuch as Fame in the Æneid, and the Temple of Love in the Henriade, may find place in a deſcription: but to introduce Diſcord as a real perſonage, imploring the aſſiſtance of Love as another real perſonage, to enervate the courage of the hero, is making theſe figurative beings act beyond their ſphere, and creating a ſtrange jumble of truth and fiction. The allegory of Sin and Death in the Paradiſe Loſt is poſſibly not generally reliſhed, though it is not entirely of the ſame nature with what we have been condemning; in a work comprehending the atchievements of ſuperior beings there is more room for fancy than where it is confined to human actions.

What is the true notion of an epiſode? or how is it to be diſtinguiſhed from the principal action? Every incident that promotes or retards the cataſtrophe muſt be part of the principal action. This clears the nature of an epiſode; which may be defined, "An incident connected with the principal action, but contributing neither to advance nor retard it." The deſcent of Æneas into hell does not advance nor retard the cataſtrophe, and therefore is an epiſode. The ſtory of Niſus and Euryalus, producing an alteration in the affairs of the contending parties, is a part of the principal action. The family-ſcene in the ſixth book of the Iliad is of the ſame nature; for by Hector's retiring from the field of battle to viſit his wife, the Grecians had opportunity to breathe, and even to turn upon the Trojans. The unavoidable effect of an epiſode according to this definition muſt be, to break the unity of action; and therefore it ought never to be indulged unleſs to unbend the mind after the fatigue of a long narration. An epiſode, when ſuch is its purpoſe, requires the following conditions: it ought to be well connected with the principal action; it ought to be lively and intereſting; it ought to be ſhort; and a time ought to be choſen when the principal action relents (E). 97

Of the Epopee.

97 What conſtitutes a good epiſode.

In the following beautiful epiſode, which cloſes the ſecond book of Fingal, all theſe conditions are united.

"Comal was a ſon of Albion; the chief of an hundred hills. His deer drunk of a thouſand ſtreams; and a thouſand rocks replied to the voice of his dogs. His face was the mildneſs of youth; but his hand the death of heroes. One was his love, and fair was ſhe! the daughter of mighty Conloch. She appeared like a ſunbeam among women, and her hair was like the wing of the raven. Her ſoul was fixed on Comal, and ſhe was his companion in the chace. Often met their eyes of love, and happy were their words in ſecret. But Gormal loved the maid, the chief of gloomy Ardven. He watched her lone ſteps on the heath, the foe of unhappy Comal.

"One day, tired of the chace, when the miſt had concealed their friends, Comal and the daughter of Conloch met in the cave of Ronan. It was the wonted haunt of Comal. Its ſides were hung with his arms; a hundred ſhields of thongs were there, a hundred helms of ſounding ſteel. Reſt here, ſaid he, my love Galvina, thou light of the cave of Ronan: a deer appears on Mora's brow; I go, but ſoon will return. I fear, ſaid ſhe, dark Gormal my foe: I will reſt here; but ſoon return, my love.

"He went to the deer of Mora. The daughter of Conloch, to try his love, clothed her white ſide with his armour, and ſtrode from the cave of Ronan. Thinking her his foe, his heart beat high, and his colour changed. He drew the bow: the arrow flew: Galvina fell in blood. He ran to the cave with haſty ſteps, and called the daughter of Conloch. Where art thou, my love? but no anſwer.——He marked, at length, her heaving heart beating againſt the mortal arrow. O Conloch's daughter, is it thou!—he ſunk upon her breaſt.

"The hunters found the hapleſs pair. Many and ſilent were his ſteps round the dark dwellings of his love. The fleet of the ocean came: he fought, and the ſtrangers fell: he ſearched for death over the field; but who could kill the mighty Comal? Throwing away his ſhield, an arrow found his manly breaſt. He ſleeps with his Galvina: their green tombs are ſeen by the mariner when he bounds on the waves of the north."

Next, upon the peculiarities of a *dramatic poem*. And the

(E) Homer's deſcription of the ſhield of Achilles is properly introduced at a time when the action relents, and the reader can bear an interruption. But the author of Telemachus deſcribes the ſhield of that young hero in the heat of battle; a very improper time for an interruption.

Of the Drama.

98 Double plot in a drama seldom successful.

the first we shall mention is a double plot: one of which must resemble an episode in an epic poem; for it would distract the spectator, instead of entertaining him, if he were forced to attend at the same time to two capital plots equally interesting. And even supposing it an under-plot like an episode, it seldom hath a good effect in tragedy, of which simplicity is a chief property; for an interesting subject that engages our affections, occupies our whole attention, and leaves no room for any separate concern. Variety is more tolerable in comedy; which pretends only to amuse, without totally occupying the mind. But even there, to make a double plot agreeable, is no slight effort of art: the under-plot ought not to vary greatly in its tone from the principal; for discordant emotions are unpleasant when jumbled together; which, by the way, is an insuperable objection to tragi-comedy. Upon that account the Provok'd Husband deserves censure; all the scenes that bring the family of the Wrongheads into action, being ludicrous and farcical, are in a very different tone from the principal scenes, displaying severe and bitter expostulations between Lord Townley and his lady. The same objection touches not the double plot of the Careless Husband; the different subjects being sweetly connected, and having only so much variety as to resemble shades of colours harmoniously mixed. But this is not all. The under-plot ought to be connected with that which is principal, so much at least as to employ the same persons: the under-plot ought to occupy the intervals or pauses of the principal action; and both ought to be concluded together. This is the case of the Merry Wives of Windsor.

99 Violent action ought not to be represented.

Violent action ought never to be represented on the stage. While the dialogue goes on, a thousand particulars concur to delude us into an impression of reality; genuine sentiments, passionate language, and persuasive gesture: the spectator, once engaged, is willing to be deceived, loses sight of himself, and without scruple enjoys the spectacle as a reality. From this absent state he is roused by violent action; he wakes as from a pleasing dream; and, gathering his senses about him, finds all to be a fiction. Horace delivers the same rule; and founds it upon the same reason:

> Ne pueros coram populo Medea trucidet;
> Aut humana palam coquat exta nefarius Atreus;
> Aut in avem Progne vertatur, Cadmus in anguem:
> Quodcumque ostendis mihi sic, incredulus odi.

The French critics join with Horace in excluding blood from the stage; but overlooking the most substantial objection, they urge only that it is barbarous and shocking to a polite audience. The Greeks had no notion of such delicacy, or rather effiminacy; witness the murder of Clytemnestra by her son Orestes, passing behind the scene, as represented by Sophocles: her voice is heard calling out for mercy, bitter expostulations on his part, loud shrieks upon her being stabbed, and then a deep silence. An appeal may be made to every person of feeling, whether this scene be not more horrible than if the deed had been committed in sight of the spectators upon a sudden gust of passion. If Corneille, in representing the affair between Horatius and his sister, upon which the murder ensues behind the scene, had no other view but to remove from the spectators a shocking action, he was guilty of a capital mistake: for murder in cold blood, which in some measure was the case as represented, is more shocking to a polite audience, even where the conclusive stab is not seen, than the same act performed in their presence by violent and unpremeditated passion, as suddenly repented of as committed. Addison's observation is just †, That no part of this incident ought to have been represented, but reserved for a narrative, with every alleviating circumstance in favour of the hero.

† Sp. N° 4

The conduct of the dialogue.

A few words upon the dialogue, which ought to be so conducted as to be a true representation of nature. We talk not here of the sentiments nor of the language (which are treated elsewhere): but of what properly belongs to dialogue-writing; where every single speech, short or long, ought to arise from what is said by the former speaker, and furnish matter for what comes after till the end of the scene. In this view, all the speeches from first to last represent so many links of one regular chain. No author, ancient or modern, possesses the art of dialogue equal to Shakespeare. Dryden, in that particular, may justly be placed as his opposite. He frequently introduces three or four persons speaking upon the same subject, each throwing out his own notions separately, without regarding what is said by the rest: take for an example the first scene of Aurenzebe. Sometimes he makes a number club in relating an event, not to a stranger, supposed ignorant of it, but to one another, for the sake merely of speaking: of which notable sort of dialogue we have a specimen in the first scene of the first part of the Conquest of Granada. In the second part of the same tragedy, scene second, the King, Abenamar, and Zulema, make their separate observations, like so many soliloquies, upon the fluctuating temper of the mob: a dialogue so uncouth puts one in mind of two shepherds in a pastoral excited by a prize to pronounce verses alternately, each in praise of his own mistress.

This manner of dialogue-writing, beside an unnatural air, has another bad effect: it stays the course of the action, because it is not productive of any consequence. In Congreve's comedies, the action is often suspended to make way for a play of wit.

No fault is more common among writers than to prolong a speech after the impatience of the person to whom it is addressed ought to prompt him or her to break in. Consider only how the impatient actor is to behave in the mean time. To express his impatience in violent action without interrupting would be unnatural; and yet to dissemble his impatience, by appearing cool where he ought to be highly inflamed, would be no less so.

Rhyme being unnatural and disgustful in dialogue, is happily banished from our theatre: the only wonder is that it ever found admittance, especially among a people accustomed to the more manly freedom of Shakespeare's dialogue. By banishing rhyme, we have gained so much as never once to dream that there can be any further improvement. And yet, however suitable blank verse may be to elevated characters and warm passions, it must appear improper and affected in the mouths of the lower sort. Why then should it be a rule, That every scene in tragedy must be in blank verse? Shakespeare, with great judgment, has followed a different rule; which is, to intermix prose with verse, and only to employ the latter where it is required by the importance or dignity of the subject. Familiar thoughts and ordinary facts ought to be expressed in plain language: to hear, for example,

a footman deliver a simple message in blank verse must appear ridiculous to every one who is not biassed by custom. In short, that variety of characters and of situations, which is the life of a play, requires not only a suitable variety in the sentiments, but also in the diction.

§ 3. *The Three Unities.*

WHEN we consider the chain of causes and effects in the material world, independent of purpose, design, or thought, we find a number of incidents in succession, without beginning, middle, or end: every thing that happens is both a cause and an effect; being the effect of what goes before, and the cause of what follows: one incident may affect us more, another less; but all of them are links in the universal chain: the mind, in viewing these incidents, cannot rest or settle ultimately upon any one; but is carried along in the train without any close.

But when the intellectual world is taken under view, in conjunction with the material, the scene is varied. Man acts with deliberation, will, and choice: he aims at some end; glory, for example, or riches, or conquest, the procuring happiness to individuals, or to his country in general: he proposes means, and lays plans to attain the end proposed. Here are a number of facts or incidents leading to the end in view, the whole composing one chain by the relation of cause and effect. In running over a series of such facts or incidents, we cannot rest upon any one; because they are presented to us as means only, leading to some end: but we rest with satisfaction upon the end or ultimate event; because there the purpose or aim of the chief person or persons is accomplished. This indicates the beginning, the middle, and the end, of what Aristotle calls *an entire action* *. The story naturally begins with describing those circumstances which move the person who acts the principal part to form a plan, in order to compass some desired event; the prosecution of that plan, and the obstructions, carry the reader into the heat of action; the middle is properly where the action is the most involved; and the end is where the event is brought about, and the plan accomplished.

We have given the foregoing example of a plan crowned with success, because it affords the clearest conception of a beginning, a middle, and an end, in which consists *unity* of action; and indeed stricter unity cannot be imagined than in that case. But an action may have unity, or a beginning, middle, and end, without so intimate a relation of parts; as where the catastrophe is different from what is intended or desired, which frequently happens in our best tragedies. In the Æneid, the hero, after many obstructions, makes his plan effectual. The Iliad is formed upon a different model: it begins with the quarrel between Achilles and Agamemnon; goes on to describe the several effects produced by that cause; and ends in a reconciliation. Here is unity of action, no doubt, a beginning, a middle, and an end; but inferior to that of the Æneid, which will thus appear. The mind hath a propensity to go forward in the chain of history; it keeps always in view the expected event; and when the incidents or underparts are connected by their relation to the event, the mind runs sweetly and easily along them. This pleasure we have in the Æneid. It is not altogether so pleasant to connect, as in the Iliad, effects by their common cause; for such connection forces the mind to a continual retrospect: looking backward is like walking backward. The three Unities.

102 Unity of action a capital beauty.

If unity of action be a capital beauty in fable imitative of human affairs, a plurality of unconnected fables must be a capital deformity. For the sake of variety, we indulge an under-plot that is connected with the principal: but two unconnected events are extremely unpleasant, even where the same actors are engaged in both. Ariosto is quite licentious in that particular: he carries on at the same time a plurality of unconnected stories. His only excuse is, that his plan is perfectly well adjusted to his subject; for every thing in the *Orlando Furioso* is wild and extravagant.

Though to state facts in the order of time is natural, yet that order may be varied for the sake of conspicuous beauties. If, for example, a noted story, cold and simple in its first movements, be made the subject of an epic poem, the reader may be hurried into the heat of action; reserving the preliminaries for a conversation-piece, if thought necessary: and that method, at the same time, hath a peculiar beauty from being dramatic. But a privilege that deviates from nature ought to be sparingly indulged; and yet romance-writers make no difficulty of presenting to the reader, without the least preparation, unknown persons engaged in some arduous adventure equally unknown. In Cassandra, two personages, who afterwards are discovered to be the heroes of the fable, start up completely armed upon the banks of the Euphrates, and engage in a single combat.

A play analysed is a chain of connected facts, of which each scene makes a link. Each scene, accordingly, ought to produce some incident relative to the catastrophe or ultimate event, by advancing or retarding it. A scene that produceth no incident, and for that reason may be termed *barren*, ought not to be indulged, because it breaks the unity of action: a barren scene can never be intitled to a place, because the chain is complete without it. In the Old Bachelor, the 3d scene of act 2. and all that follow to the end of that act, are mere conversation-pieces, productive of no consequence. The 10th and 11th scenes, act 3. Double Dealer, and the 10th, 11th, 12th, 13th, and 14th scenes, act 1. Love for Love, are of the same kind. Neither is The Way of the World entirely guiltless of such scenes. It will be no justification that they help to display characters: it were better, like Dryden in his *dramatis personæ*, to describe characters beforehand, which would not break the chain of action. But a writer of genius has no occasion for such artifice: he can display the characters of his personages much more to the life in sentiment and action. How successfully is this done by Shakespeare! in whose works there is not to be found a single barren scene.

Upon the whole, it appears, that all the facts in an historical fable ought to have a mutual connection, by their common relation to the grand event or catastrophe. And this relation, in which the *unity* of action consists, is equally essential to epic and dramatic compositions.

103 Whether unity of time and of place be essential.

How far the unities of time and of place are essential, is a question of greater intricacy. These unities were strictly observed in the Greek and Roman theatres; and they are inculcated by the French and English critics as essential to every dramatic composition. In theory these

The three Unities.

theſe unities are alſo acknowledged by our beſt poets, though their practice ſeldom correſponds: they are often forced to take liberties, which they pretend not to juſtify, againſt the practice of the Greeks and Romans, and againſt the ſolemn deciſion of their own countrymen. But in the courſe of this inquiry it will be made evident, that in this article we are under no neceſſity to copy the ancients; and that our critics are guilty of a miſtake, in admitting no greater latitude of place and time than was admitted in Greece and Rome.

Indeed the unities of place and time are not, by the moſt rigid critics, required in a narrative poem. In ſuch compoſition, if it pretend to copy nature, theſe unities would be abſurd; becauſe real events are ſeldom confined within narrow limits either of place or of time: and yet we can follow hiſtory, or an hiſtorical fable, through all its changes, with the greateſt facility: we never once think of meaſuring the real time by what is taken in reading; nor of forming any connection between the place of action and that which we occupy.

We are aware, that the drama differs ſo far from the epic as to admit different rules. It will be obſerved, "That an hiſtorical fable, intended for reading ſolely, is under no limitation of time or of place more than a genuine hiſtory; but that a dramatic compoſition cannot be accurately repreſented unleſs it be limited, as its repreſentation is, to one place and to a few hours; and therefore that no fable can be admitted but what has theſe properties, becauſe it would be abſurd to compoſe a piece for repreſentation that cannot be juſtly repreſented." This argument has at leaſt a plauſible appearance; and yet one is apt to ſuſpect ſome fallacy, conſidering that no critic, however ſtrict, has ventured to confine the unities of place and of time within ſo narrow bounds.

A view of the Grecian drama, compared with our own, may perhaps relieve us from this dilemma: if they be differently conſtructed, as ſhall be made evident, it is poſſible that the foregoing reaſoning may not be equally applicable to both.

104 They were eſſential to the Greek drama, but

All authors agree, that tragedy in Greece was derived from the hymns in praiſe of Bacchus, which were ſung in parts by a chorus. Theſpis, to relieve the ſingers, and for the ſake of variety, introduced one actor, whoſe province it was to explain hiſtorically the ſubject of the ſong, and who occaſionally repreſented one or other perſonage. Eſchylus, introducing a ſecond actor, formed the dialogue; by which the performance became dramatic; and the actors were multiplied when the ſubject repreſented made it neceſſary. But ſtill the chorus, which gave a beginning to tragedy, was conſidered as an eſſential part. The firſt ſcene, generally, unfolds the preliminary circumſtances that lead to the grand event; and this ſcene is by Ariſtotle termed the *prologue*. In the ſecond ſcene, where the action properly begins, the chorus is introduced, which, as originally, continues upon the ſtage during the whole performance: the chorus frequently makes one in the dialogue; and when the dialogue happens to be ſuſpended, the chorus, during the interval, is employed in ſinging. Sophocles adheres to this plan religiouſly. Euripides is not altogether ſo correct. In ſome of his pieces it becomes neceſſary to remove the chorus for a little time: but when that unuſual ſtep is riſked, matters are ſo ordered as not to interrupt the repreſentation: the chorus never leave the ſtage of their own accord, but at the command of ſome principal perſonage, who conſtantly waits their return.

Thus the Grecian drama is a continued repreſentation without any interruption; a circumſtance that merits attention. A continued repreſentation without a pauſe affords not opportunity to vary the place of action, nor to prolong the time of the action beyond that of the repreſentation. To a repreſentation ſo confined in place and time, the foregoing reaſoning is ſtrictly applicable: a real or feigned action, that is brought to a concluſion after conſiderable intervals of time and frequent changes of place, cannot accurately be copied in a repreſentation that admits no latitude in either. Hence it is, that the unities of place and of time, were, or ought to have been, ſtrictly obſerved in the Greek tragedies; which is made neceſſary by the very conſtitution of their drama, for it is abſurd to compoſe a tragedy that cannot be juſtly repreſented.

10[5] Not [to] Fren[ch] Engl[iſh]

Modern critics, who for our drama pretend to eſtabliſh rules founded on the practice of the Greeks, are guilty of an egregious blunder. The unities of place and of time were in Greece, as we ſee, a matter of neceſſity, not of choice; and it is eaſy to ſhow, that if we ſubmit to ſuch fetters, it muſt be from choice, not neceſſity. This will be evident upon taking a view of the conſtitution of our drama, which differs widely from that of Greece; whether more or leſs perfect, is a different point, to be handled afterward. By dropping the chorus, opportunity is afforded to divide the repreſentation by intervals of time, during which the ſtage is evacuated and the ſpectacle ſuſpended. This qualifies our drama for ſubjects ſpread through a wide ſpace both of time and of place: the time ſuppoſed to paſs during the ſuſpenſion of the repreſentation is not meaſured by the time of the ſuſpenſion; and any place may be ſuppoſed, as it is not in ſight: by which means, many ſubjects can juſtly be repreſented in our theatres, that were excluded from thoſe of ancient Greece. This doctrine may be illuſtrated, by comparing a modern play to a ſet of hiſtorical pictures; let us ſuppoſe them five in number, and the reſemblance will be complete: each of the pictures reſembles an act in one of our plays: there muſt neceſſarily be the ſtricteſt unity of place and of time in each picture; and the ſame neceſſity requires theſe two unities during each act of a play, becauſe during an act there is no interruption in the ſpectacle. Now, when we view in ſucceſſion a number of ſuch hiſtorical pictures, let it be, for example, the hiſtory of Alexander by Le Brun, we have no difficulty to conceive, that months or years have paſſed between the events exhibited in two different pictures, though the interruption is imperceptible in paſſing our eye from the one to the other; and we have as little difficulty to conceive a change of place, however great: in which view, there is truly no difference between five acts of a modern play and five ſuch pictures. Where the repreſentation is ſuſpended, we can with the greateſt facility ſuppoſe any length of time or any change of place: the ſpectator, it is true, may be conſcious, that the real time and place are not the ſame with what are employed in the repreſentation; but this is a work of reflection; and by the ſame reflection he may alſo be conſcious, that Garrick is not King Lear, that the playhouſe is not Dover cliffs, nor the noiſe he hears thunder and lightning. In a word, after an interruption of the repreſentation, it is not more

more difficult for a ſpectator to imagine a new place, or a different time, than, at the commencement of the play, to imagine himſelf at Rome, or in a period of time two thouſand years back. And indeed, it is abundantly ridiculous, that a critic, who is willing to hold candle-light for ſun-ſhine, and ſome painted canvaſſes for a palace or a priſon, ſhould affect ſo much difficulty in imagining a latitude of place or of time in the fable, beyond what is neceſſary in the repreſentation.

There are, it muſt be acknowledged, ſome effects of great latitude in time that ought never to be indulged in a compoſition for the theatre: nothing can be more abſurd, than at the cloſe to exhibit a full-grown perſon who appears a child at the beginning: the mind rejects, as contrary to all probability, ſuch latitude of time as is requiſite for a change ſo remarkable. The greateſt change from place to place hath not altogether the ſame bad effect: in the bulk of human affairs place is not material; and the mind, when occupied with an intereſting event, is little regardful of minute circumſtances: theſe may be varied at will, becauſe they ſcarce make any impreſſion.

At the ſame time, it is not here meant to juſtify liberty without any reſerve. An unbounded licence with relation to place and time, is faulty, for a reaſon that ſeems to have been overlooked, which is, that it ſeldom fails to break the unity of action; in the ordinary courſe of human affairs, ſingle events, ſuch as are fit to be repreſented on the ſtage, are confined to a narrow ſpot, and generally employ no great extent of time: we accordingly ſeldom find ſtrict unity of action in a dramatic compoſition, where any remarkable latitude is indulged in theſe particulars. It may even be admitted, that a compoſition which employs but one place, and requires not a greater length of time than is neceſſary for the repreſentation, is ſo much the more perfect; becauſe the confining an event within ſo narrow bounds, contributes to the unity of action, and alſo prevents that labour, however ſlight, which the mind muſt undergo in imagining frequent changes of place, and many intervals of time. But ſtill we muſt inſiſt, that ſuch limitation of place and time as was neceſſary in the Grecian drama, is no rule to us; and therefore, that though ſuch limitation adds one beauty more to the compoſition, it is at beſt but a refinement, which may juſtly give place to a thouſand beauties more ſubſtantial. And we may add, that it is extremely difficult, if not impracticable, to contract within the Grecian limits any fable ſo fruitful of incidents in number and variety as to give full ſcope to the fluctuation of paſſion.

It may now appear, that critics who put the unities of place and of time upon the ſame footing with the unity of action, making them all equally eſſential, have not attended to the nature and conſtitution of the modern drama. If they admit an interrupted repreſentation, with which no writer finds fault, it is abſurd to reject its greateſt advantage, that of repreſenting many intereſting ſubjects excluded from the Grecian ſtage. If there needs muſt be a reformation, why not reſtore the ancient chorus and the ancient continuity of action? There is certainly no medium; for to admit an interruption without relaxing from the ſtrict unities of place and of time, is in effect to load us with all the inconveniences of the ancient drama, and at the ſame time to with-hold from us its advantages.

And therefore the only proper queſtion is, Whether our model be or be not a real improvement? This indeed may fairly be called in queſtion; and in order to a comparative trial, ſome particulars muſt be premiſed. When a play begins, we have no difficulty to adjuſt our imagination to the ſcene of action, however diſtant it be in time or in place; becauſe we know that the play is a repreſentation only. The caſe is very different after we are engaged: it is the perfection of repreſentation to hide itſelf, to impoſe on the ſpectator, and to produce in him an impreſſion of reality, as if he were ſpectator of a real event; but any interruption annihilates that impreſſion, by rouſing him out of his waking dream, and unhappily reſtoring him to his ſenſes. So difficult it is to ſupport the impreſſion of reality, that much ſlighter interruptions than the interval between two acts are ſufficient to diſſolve the charm: in the 5th act of the *Mourning Bride*, the three firſt ſcenes are in a room of ſtate, the fourth in a priſon; and the change is operated by ſhifting the ſcene, which is done in a trice: but however quick the tranſition may be, it is impracticable to impoſe upon the ſpectators ſo as to make them conceive that they are actually carried from the palace to the priſon; they immediately reflect, that the palace and priſon are imaginary, and that the whole is a fiction.

The three Unities.

108
Whether our drama be preferable to that of Greece.

From theſe premiſes, one will naturally be led, at firſt view, to pronounce the frequent interruptions in the modern drama to be an imperfection. It will occur, "That every interruption muſt have the effect to baniſh the dream of reality, and with it to baniſh our concern, which cannot ſubſiſt while we are conſcious that all is a fiction; and therefore, that in the modern drama, ſufficient time is not afforded for fluctuation and ſwelling of paſſion, like what is afforded in that of Greece, where there is no interruption." This reaſoning, it muſt be owned, has a ſpecious appearance: but we muſt not become faint-hearted upon the firſt repulſe; let us rally our troops for a ſecond engagement.

On the Greek ſtage, whatever may have been the caſe on the Roman, the repreſentation was never interrupted, and the diviſion by acts was totally unknown. The word *act* never once occurs in Ariſtotle's Poetics, in which he defines exactly every part of the drama, and divides it into the beginning, the middle, and the end. At certain intervals indeed the actors retired; but the ſtage was not then left empty, nor the curtain let fall; for the chorus continued and ſung. Neither do theſe ſongs of the chorus divide the Greek tragedies into five portions, ſimilar to our acts; though ſome of the commentators have endeavoured to force them into this office. But it is plain, that the intervals at which the chorus ſung are extremely unequal and irregular, ſuited to the occaſion and the ſubject; and would divide the play ſometimes into three, ſometimes into ſeven or eight acts.

As practice has now eſtabliſhed a different plan on the modern ſtage, has divided every play into five acts, and made a total pauſe in the repreſentation at the end of each act, the queſtion to be conſidered is, Whether the plan of the ancient or of the modern drama is beſt qualified for making a deep impreſſion on the mind? That the preference is due to the plan of the modern drama, will be evident from the following conſiderations. If it be indeed true, as the advocates for the three unities allege, that the audience is deluded into the belief

The three Unities.

of the reality of a well-acted tragedy, it is certain that this deluſion cannot be long ſupported; for when the ſpirits are exhauſted by cloſe attention, and by the agitation of paſſion, an uneaſineſs enſues, which never fails to baniſh the waking dream. Now ſuppoſing the time that a man can employ with ſtrict attention without wandering to be no greater than is requiſite for a ſingle act (a ſuppoſition that cannot be far from truth), it follows, that a continued repreſentation of longer endurance than an act, inſtead of giving ſcope to fluctuation and ſwelling of paſſion, would overſtrain the attention, and produce a total abſence of mind. In this reſpect, the four pauſes have a fine effect: for by affording to the audience a ſeaſonable reſpite when the impreſſion of reality is gone, and while nothing material is in agitation, they relieve the mind from its fatigue; and conſequently prevent a wandering of thought at the very time poſſibly of the moſt intereſting ſcenes.

In one article, indeed, the Grecian model has greatly the advantage: its chorus, during an interval, not only preſerves alive the impreſſions made upon the audience, but alſo prepares their hearts finely for new impreſſions. In our theatres, on the contrary, the audience, at the end of every act, being left to trifle time away, loſe every warm impreſſion; and they begin the next act cool and unconcerned, as at the commencement of the repreſentation. This is a groſs malady in our theatrical repreſentations; but a malady that luckily is not incurable: to revive the Grecian chorus, would be to revive the Grecian ſlavery of place and time; but we can figure a detached chorus coinciding with a pauſe in the repreſentation, as the ancient chorus did with a pauſe in the principal action. What objection, for example, can there lie againſt muſic between the acts, vocal and inſtrumental, adapted to the ſubject? Such detached chorus, without putting us under any limitation of time or place, would recruit the ſpirits, and would preſerve entire the tone, if not the tide, of paſſion: the muſic, after an act, ſhould commence in the tone of the preceding paſſion, and be gradually varied till it accord with the tone of the paſſion that is to ſucceed in the next act. The muſic and the repreſentation would both of them be gainers by their conjunction; which will thus appear. Muſic that accords with the preſent tone of mind, is, on that account, doubly agreeable; and accordingly, though muſic ſingly hath not power to raiſe a paſſion, it tends greatly to ſupport a paſſion already raiſed. Further, muſic prepares us for the paſſion that follows, by making cheerful, tender, melancholy, or animated impreſſions, as the ſubject requires. Take for an example the firſt ſcene of the *Mourning Bride*, where ſoft muſic, in a melancholy ſtrain, prepares us for Almeria's deep diſtreſs. In this manner, muſic and repreſentation ſupport each other delightfully: the impreſſion made upon the audience by the repreſentation, is a fine preparation for the muſic that ſucceeds; and the impreſſion made by the muſic, is a fine preparation for the repreſentation that ſucceeds. It appears evident, that by ſome ſuch contrivance, the modern drama may be improved, ſo as to enjoy the advantage of the ancient chorus without its ſlaviſh limitation of place and time. But to return to the compariſon between the ancient and the modern drama.

109 An improvement of the modern drama ſuggeſted *Elem. of Criticiſm*, ch. 23.

The numberleſs improprieties forced upon the Greek dramatic poets by the conſtitution of their drama, may be ſufficient, one ſhould think, to make us prefer the modern drama, even abſtracting from the improvement propoſed. To prepare the reader for this article, it muſt be premiſed, that as in the ancient drama the place of action never varies, a place neceſſarily muſt be choſen to which every perſon may have acceſs without any improbability. This confines the ſcene to ſome open place, generally the court or area before a palace; which excludes from the Grecian theatre tranſactions within doors, though theſe commonly are the moſt important. Such cruel reſtraint is of itſelf ſufficient to cramp the moſt pregnant invention; and accordingly the Greek writers, in order to preſerve unity of place, are reduced to woful improprieties. In the *Hippolytus* of Euripides (act 1. ſc. 6.), Phedra, diſtreſſed in mind and body, is carried without any pretext from her palace to the place of action; is there laid upon a couch, unable to ſupport herſelf upon her limbs; and made to utter many things improper to be heard by a number of women who form the chorus: and what is ſtill more improper, her female attendant uſes the ſtrongeſt intreaties to make her reveal the ſecret cauſe of her anguiſh; which at laſt Phedra, contrary to decency and probability, is prevailed upon to do in preſence of that very chorus (act 2. ſc. 2.) Alceſtes, in Euripides, at the point of death, is brought from the palace to the place of action, groaning and lamenting her untimely fate (act 2. ſc. 1.) In the *Trachiniæ* of Sophocles (act. 2.), a ſecret is imparted to Dejanira, the wife of Hercules, in preſence of the chorus. In the tragedy of *Iphigenia*, the meſſenger employed to inform Clytemneſtra that Iphigenia was ſacrificed, ſtops ſhort at the place of action, and with a loud voice calls the queen from her palace to hear the news. Again, in the *Iphigenia in Tauris* (act 4.), the neceſſary preſence of the chorus forces Euripides into a groſs abſurdity, which is to form a ſecret in their hearing; and, to diſguiſe the abſurdity, much court is paid to the chorus, not one woman but a number, to engage them to ſecrecy. In the *Medea* of Euripides, that princeſs makes no difficulty, in preſence of the chorus, to plot the death of her huſband, of his miſtreſs, and of her father the king of Corinth, all by poiſon: it was neceſſary to bring Medea upon the ſtage; and there is but one place of action, which is always occupied by the chorus. This ſcene cloſes the ſecond act; and in the end of the third, ſhe frankly makes the chorus her confidents in plotting the murder of her own children. Terence, by identity of place, is often forced to make a converſation within doors be heard on the open ſtreet: the cries of a woman in labour are there heard diſtinctly.

The Greek poets are not leſs hampered by unity of time than by that of place. In the *Hippolytus* of Euripides, that prince is baniſhed at the end of the 4th act; and in the firſt ſcene of the following act, a meſſenger relates to Theſeus the whole particulars of the death of Hippolytus by the ſea-monſter: that remarkable event muſt have occupied many hours; and yet in the repreſentation it is confined to the time employed by the chorus upon the ſong at the end of the 4th act. The inconſiſtency is ſtill greater in the *Iphigenia in Tauris* (act 5. ſc. 4.): the ſong could not exhauſt half an hour; and yet the incidents ſuppoſed to have happened during that time could not naturally have been tranſacted in leſs than half a day.

The

The Greek artiſts are forced, not leſs frequently, to tranſgreſs another rule, derived alſo from a continued repreſentation. The rule is, that as a vacuity, however momentary, interrupts the repreſentation, it is neceſſary that the place of action be conſtantly occupied. Sophocles, with regard to that rule as well as to others, is generally correct: but Euripides cannot bear ſuch reſtraint; he often evacuates the ſtage, and leaves it empty for others. Iphigenia in Tauris, after pronouncing a ſoliloquy in the firſt ſcene, leaves the place of action, and is ſucceeded by Oreſtes and Pylades: they, after ſome converſation, walk off; and Iphigenia re-enters, accompanied with the chorus. In the Alceſtes, which is of the ſame author, the place of action is void at the end of the third act. It is true, that to cover the irregularity, and to preſerve the repreſentation in motion, Euripides is careful to fill the ſtage without loſs of time: but this ſtill is an interruption, and a link of the chain broken: for during the change of the actors, there muſt be a ſpace of time, during which the ſtage is occupied by neither ſet. It makes indeed a more remarkable interruption, to change the place of action as well as the actors; but that was not practicable upon the Grecian ſtage.

It is hard to ſay upon what model Terence has formed his plays. Having no chorus, there is a pauſe in the repreſentation at the end of every act: but advantage is not taken of the ceſſation, even to vary the place of action; for the ſtreet is always choſen, where every thing paſſing may be ſeen by every perſon; and by that choice, the moſt ſprightly and intereſting parts of the action, which commonly paſs within doors, are excluded; witneſs the laſt act of the *Eunuch*. He hath ſubmitted to the like ſlavery with reſpect to time. In a word, a play with a regular chorus, is not more confined in place and time than his plays are. Thus a zealous ſectary follows implicitly ancient forms and ceremonies, without once conſidering whether their introductive cauſe be ſtill ſubſiſting. Plautus, of a bolder genius than Terence, makes good uſe of the liberty afforded by an interrupted repreſentation: he varies the place of action upon all occaſions, when the variation ſuits his purpoſe.

The intelligent reader will by this time underſtand, that we plead for no change of place in our plays but after an interval, nor for any latitude in point of time but what falls in with an interval. The unities of place and time ought to be ſtrictly obſerved during each act; for during the repreſentation there is no opportunity for the ſmalleſt deviation from either. Hence it is an eſſential requiſite, that during an act the ſtage be always occupied; for even a momentary vacuity makes an interval or interruption. Another rule is no leſs eſſential: it would be a groſs breach of the unity of action to exhibit upon the ſtage two ſeparate actions at the ſame time; and therefore, to preſerve that unity, it is neceſſary that each perſonage introduced during an act be linked to thoſe in poſſeſſion of the ſtage, ſo as to join all in one action. Theſe things follow from the very conception of an act, which admits not the ſlighteſt interruption: the moment the repreſentation is intermitted, there is an end of that act; and we have no other notion of a new act, but where, after a pauſe or interval, the repreſentation is again put in motion. French writers, generally ſpeaking, are correct in this particular. The Engliſh, on the contrary, are ſo irregular as ſcarce to deſerve a criticiſm: actors not only ſucceed each other in the ſame place without connection, but, what is ſtill leſs excuſable, they frequently ſucceed each other in different places. This change of place in the ſame act ought never to be indulged; for, beſide breaking the unity of the act, it has a diſagreeable effect: after an interval, the imagination adapts itſelf to any place that is neceſſary, as readily as at the commencement of the play; but during the repreſentation we reject change of place. From the foregoing cenſure muſt be excepted the *Mourning Bride* of Congreve, where regularity concurs with the beauty of ſentiment and of language, to make it one of the moſt complete pieces England has to boaſt of. It is to be acknowledged, however, that in point of regularity this elegant performance is not altogether unexceptionable. In the four firſt acts, the unities of place and time are ſtrictly obſerved: but in the laſt act, there is a capital error with reſpect to unity of place; for in the three firſt ſcenes of that act, the place of action is a room of ſtate, which is changed to a priſon in the fourth ſcene; the chain alſo of the actors is broken; as the perſons introduced in the priſon are different from thoſe who made their appearance in the room of ſtate. This remarkable interruption of the repreſentation makes in effect two acts inſtead of one: and therefore, if it be a rule that a play ought not to conſiſt of more acts than five, this performance is ſo far defective in point of regularity. It may be added, that, even admitting ſix acts, the irregularity would not be altogether removed, without a longer pauſe in the repreſentation than is allowed in the acting; for more than a momentary interruption is requiſite for enabling the imagination readily to fall in with a new place, or with a wide ſpace of time. In *The Way of the World*, of the ſame author, unity of place is preſerved during every act, and a ſtricter unity of time during the whole play than is neceſſary.

Of the Opera.

§ 4. *Of the Opera.*

113
The opera, a drama repreſented by muſic.

An opera is a drama repreſented by muſic. This entertainment was invented at Venice. An exhibition of this ſort requires a moſt brilliant magnificence, and an expence truly royal. The drama muſt neceſſarily be compoſed in verſe; for as operas are ſung and accompanied with ſymphonies, they muſt be in verſe to be properly applicable to muſic. To render this entertainment ſtill more brilliant, it is ornamented with dances and ballettes, with ſuperb decorations, and ſurpriſing machinery. The dreſſes of the actors, of thoſe who aſſiſt in the chorus, and of the dancers, being all in the moſt ſplendid and elegant taſte, contribute to render the exhibition highly ſumptuous. But notwithſtanding this union of arts and pleaſures at an immenſe expence, and notwithſtanding a moſt dazzling pageantry, an opera appears, in the eyes of many people of taſte, but as a magnificent abſurdity, ſeeing that nature is never there from the beginning to the end. It is not our buſineſs here, however, to determine between the different taſtes of mankind.

The method of expreſſing our thoughts by ſinging and muſic is ſo little natural, and has ſomething in it ſo forced and affected, that it is not eaſy to conceive how

Of the Opera.

how it could come into the minds of men of genius to represent any human action, and, what is more, a serious or tragic action, any otherwise than by speech. We have, it is true, operas in English by Addison, &c. in Italian by Metastasio, in French by M. Quinault, Fontenelle, &c. the subjects of which are so grave and tragic, that one might call them musical tragedies, and real *chefs d'œuvres* in their kind. But though we are highly satisfied and greatly affected on reading them, and are much pleased with seeing them represented, yet the spectator is, perhaps, more charmed with the magnificence of the sight and the beauty of the music, than moved with the action and the tragical part of the performance. We are not, however, of that order of critics who strive to prove, that mankind act wrong in finding pleasure in an object with which they are really pleased; who blame a lover for thinking his mistress charming, when her features are by no means regular; and who are perpetually applying the rules of logic to the works of genius: we make these observations merely in order to examine if it be not possible to augment the pleasures of a polite people, by making the opera something more natural, more probable, and more consonant to reason.

Bielfield's Elem. of Erudition.

114

Should take its subject not from history but from fable and enchantment.

We think, therefore, that the poet should never, or at least very rarely, choose a subject from history, but from fable or mythology, or from the regions of enchantment. Every rational mind is constantly shocked to hear a mutilated hero trill out, from the slender pipe of a chaffinch, *To arms! To arms!* and in the same tone animate his soldiers, and lead them to the assault; or harangue an assembly of grave senators, and sometimes a whole body of people. Nothing can be more burlesque than such exhibitions; and a man must be possessed of a very uncommon sensibility to be affected by them. But as we know not what was the language of the gods, and their manner of expressing themselves, we are at liberty in that case to form what illusions we please, and to suppose that they sung to distinguish themselves from mortals. Besides, all the magic of decorations and machinery become natural, and even necessary, in these kinds of subjects; and therefore readily afford opportunity for all the pomp of these performances. The chorus, the dances, the ballettes, the symphonies and dresses, may likewise be all made to correspond with such subjects: nothing is here affected, absurd, or unnatural. Whoever is possessed of genius, and is well acquainted with mythology, will there find an inexhaustible source of subjects highly diversified, and quite proper for the drama of an opera.

We shall not speak here of that sort of music which appears to us the most proper for such a drama, and of the several alterations of which we think it susceptible, in order to make it more complete, and to adapt it to a more pathetic, more noble, and more natural expression, as well in the recitatives as in the airs and chorus. (See Music). We have only here to consider the business of the poet. He should never lose sight of nature, even in the midst of the greatest fiction. A god, a demi-god, a renowned hero, such for example as Renaud in *Armida*, a fairy, a genie, a nymph, or fury, &c. should constantly be represented according to the characters we give them, and never be made to talk the language of a fop or a *petite maitresse*. The

115

And should represent its characters as consistent.

recitative, which is the ground-work of the dialogue, requires verses that are free and not regular, such as with a simple cadence approach the nearest to common language. The airs should not be forced into the piece, nor improperly placed for the sake of terminating a scene, or to display the voice of a performer: they should express some sentiment, or some precept, short and striking, or tender and affecting; or some simile lively and natural; and they should arise of themselves from a monologue, or from a scene between two persons: prolixity should here be particularly avoided, especially when such an air makes part of a dialogue; for nothing is more insipid or disgustful than the countenances of the other actors who appear at the same time, whose silence is quite unmeaning, and who know not what to do with their hands and feet while the singer is straining his throat. The verse of all the airs should be of the lyric kind, and should contain some poetic image, or paint some noble passion, which may furnish the composer with an opportunity of displaying his talents, and of giving a lively and affecting expression to the music. A phrase that is inanimated can never have a good effect in the performance, but must become insipid and horribly tedious in the air. The trite similies of the Italians, of a stream that flows, or a bird that flies, &c. are no longer sufferable. The same thing may be said with regard to the chorus, which should be equally natural and well adapted: it is here sometimes a whole people, sometimes the inhabitants of a peculiar country, and sometimes warriors, nymphs, or priests, &c. who raise their voice to demand justice, to implore favour, or render a general homage. The action itself will furnish the poet of genius with ideas, words, and the manner of disposing them.

Lastly, the opera being a performance calculated less to satisfy the understanding than to charm the ear and affect the heart, and especially to strike the sight, the poet should have a particular attention to that object, should be skilled in the arts of a theatre, should know how to introduce combats, ballettes, feasts, games, pompous entries, solemn processions, and such marvellous incidents as occur in the heavens, upon earth, in the sea, and even in the infernal regions; but all these matters demand a strong character, and the utmost precision in the execution: for otherwise, the comic being a near neighbour to the sublime, they will easily become ridiculous. The unity of action must certainly be observed in such a poem, and all the incidental episodes must concur to the principal design; otherwise it would be a monstrous chaos. It is impossible, however, scrupulously to observe the unity of time and place: though the liberty, which reason allows the poet in this respect, is not without bounds; and the less use he makes of it, the more perfect his poem will be. It is not perhaps impossible so to arrange the objects, that, in changing the decorations, the painter may constantly make appear some part of the principal decoration which characterises the situation of the scene, as the corner of a palace, at the end of a garden, or some avenue that leads to it, &c. But all this is liable to difficulties, and even to exceptions; and the art of the painter must concur in such case with that of the poet. For the rest, all the operas of Europe are at least one third too long; especially the Italian. The unity of action requires brevity; and satiety is inseparable from a diversion

1[illegible] Unit[illegible] actio[illegible] cessa[illegible] the o[illegible]

version that lasts full four hours, and sometimes longer.

They have indeed endeavoured to obviate this inconvenience by dividing an opera into three, and even into five acts; but experience proves, that this division, though judicious, is still not sufficient to relieve the wearied attention.

Sect. II. *Of Lyric Poetry.*

The ode is very ancient, and was probably the first species of poetry. It had its source, we may suppose, from the heart, and was employed to express, with becoming fervour and dignity, the grateful sense man entertained of the blessings which daily flowed from God the fountain of all goodness: hence their harvest hymns, and other devotional compositions of that kind.

But in process of time it was employed, not only to praise the Almighty for bounties received, but to solicit his aid in time of trouble; as is plain from the odes written by king David and others, and collected by the Jewish Sanhedrim into the book of Psalms, to be sung at their fasts, festivals, and on other solemn occasions. Nor was this practice confined to the Israelites only: other nations had their songs of praise and petitions of this sort, which they preferred to their deities in time of public prosperity and public distress, as well as to those heroes who distinguished themselves in arms. Even the American Indians, whose notions of religion are extremely confined, have their war-songs, which they sing to this day.

It is reasonable to suppose that the awful purpose to which the ode was applied, gave rise among the ancients to the custom of invoking the muses; and that the poets, in order to raise their sentiments and language, so as to be acceptable to their deities, thought it expedient to solicit some divine assistance. Hence poets are said to have been inspired, and hence an unbounded liberty has been given to the ode; for the lyric poet, fired, as it were, with his subject, and borne away on the wings of gratitude, disdains grammatical niceties and common modes of speech, and often soars above rule, though not above reason. This freedom, however, consists chiefly in sudden transitions, bold digressions, and lofty excursions. For the ancient poets, and even Pindar, the most daring and lofty of them all, has in his sublimest flights, and amidst all his rapture, preserved harmony, and often uniformity in his versification: but so great is the variety of his measures, that the traces of sameness are in a manner lost; and this is one of the excellencies for which that poet is admired, and which, though seemingly devoid of art, requires so much that he has seldom been imitated with success.

The ancients in their odes indulged such a liberty of fancy, that some of their best poets not only make bold excursions and digressions, but, having in their flights started some new and noble thought, they frequently pursue it, and never more return to their subject. But this loose kind of ode, which seems to reject all method, and in which the poet, having just touched upon his subject, immediately diverts to another, we should think blameable, were it lawful to call in question the authority of those great men who were our preceptors in this art. We may venture to affirm, however, that these compositions stand in no degree of comparison with other odes of theirs; in which, after wandering from the subject in pursuit of new ideas arising from some of its adjuncts, and ranging wantonly, as it were, through a variety of matter, the poet is from some other circumstance led naturally to his subject again; and, like a bee, having collected the essence of many different flowers, returns home, and unites them all in one uniform pleasing sweet. Of Lyric Poetry.

119 The subjects of the ode.

The ode among the ancients signified no more than a song: but with the moderns, the ode and the song are considered as different compositions; the ode being usually employed in grave and lofty subjects, and seldom sung but on solemn occasions.

The subjects most proper for the ode and song, Horace has pointed out in a few elegant lines.

Gods, heroes, conquerors, *Olympic* crowns,
Love's pleasing cares, and the free joys of wine,
Are proper subjects for the lyric song.

To which we may add, that happiness, the pleasures of a rural life, and such parts of morality as afford lessons for the promotion of our felicity, and reflections on the conduct of life, are equally suitable to the ode. This both *Pindar* and *Horace* were so sensible of, that many of their odes are seasoned with these moral sentences and reflections.

But who can number ev'ry sandy grain
Wash'd by *Sicilia*'s hoarse-resounding main?
Or who can *Theron*'s gen'rous works express,
And tell how many hearts his bounteous virtues bless?

Ode to Theron.

And in another Olympic ode, inscribed by the same poet to Diagoras of Rhodes (and in such esteem, that it was deposited in the temple of Minerva, written in letters of gold), Pindar, after exalting them to the skies, concludes with this lesson in life:

Yet as the gales of fortune various blow,
To-day tempestuous, and to-morrow fair,
Due bounds, ye Rhodians, let your transports know;
Perhaps to-morrow comes a storm of care.

West's Pindar.

The man resolv'd and steady to his trust,
Inflexible to ill, and obstinately just,
May the rude rabble's insolence despise,
Their senseless clamours and tumultuous cries;
The tyrant's fierceness he beguiles,
And the stern brow and the harsh voice defies,
And with superior greatness smiles.
Not the rough whirlwind, that deforms
Adria's black gulph, and vexes it with storms,
The stubborn virtue of his soul can move;
Nor the red arm of angry Jove,
That flings the thunder from the sky,
And gives it rage to roar, and strength to fly.
Should the whole frame of nature round him break,
In ruin and confusion hurl'd,
He unconcern'd would hear the mighty crack,
And stand secure amidst a falling world.

Horace.

Of Lyric Poetry.

M. Despreaux has given us a very beautiful and just description of the ode in these lines.

L'Ode avec plus d'éclat, & non moins d'énergie
Elevant jusqu'au ciel son vol ambitieux,
Entretient dans vers commerce avec les Dieux.
Aux Athletes dans Pise elle ouvre la barriere,
Chante un vainqueur poudreux au bout de la carriere;
Mene Achille sanglant au bords du Simoïs
Ou fait flechir l'Escaut sous le joug de Louis.
Tantôt comme une abeille ardente à son ouvrage
Elle s'en va de fleurs dèpouiller le rivage:
Elle peint les festins, les danses & les ris,
Vante un baiser cueilli sur les levres d'Iris,
Qui mollement résiste & par un doux caprice
Quelquefois le refuse, afin qu'on le ravisse.
Son style impetueux souvent marche au hasard.
Chez elle un beau desordre est un effet de l'art,
Loin ces rimeurs craintifs, dont l'esprit plegmatique
Garde dans ses fureurs un ordre didactique:
Qui chantant d'un heros les progrès éclatans,
Maigres historiens, suivront l'ordre des temps.
Apollon de son feu leur fut tonjours avare, &c.

The lofty ode demands the strongest fire,
For there the muse all Phœbus must inspire:
Mounting to heav'n in her ambitious flight,
Amongst the gods and heroes takes delight;
Of Pisa's wrestlers tells the sinewy force,
And sings the dusty conqueror's glorious course;
To Simois' banks now fierce Achilles sends,
Beneath the Gallic yoke now Escaut bends:
Sometimes she flies, like an industrious bee,
And robs the flow'rs by nature's chemistry;
Describes the shepherds dances, feasts, and bliss,
And boasts from Phillis to surprise a kiss,
When gently she resists with feign'd remorse,
That what she grants may seem to be by force.
Her generous style will oft at random start,
And by a brave disorder show her art;
Unlike those fearful poets whose cold rhyme
In all their raptures keeps exactest time,
Who sing the illustrious hero's mighty praise,
Dry journalists, by terms of weeks and days;
To these, Apollo, thrifty of his fire,
Denies a place in the Pierian choir, &c.

SOAMES.

The variety of subjects, which are allowed the *lyric* poet, makes it necessary to consider this species of poetry under the following heads, viz. the *sublime* ode, the *lesser* ode, and the *song*. We shall begin with the lowest, and proceed to that which is more eminent.

120 The song.

I. *Songs* are little poetical compositions, usually set to a tune, and frequently sung in company by way of entertainment and diversion. Of these we have in our language a great number; but, considering that number, not many which are excellent; for, as the Duke of Buckingham observes,

Though nothing seems more easy, yet no part
Of poetry requires a nicer art.

The song admits of almost any subject; but the greatest part of them turn either upon *love*, *contentment*, or the *pleasures* of a *country life*, and *drinking*. Be the subject, however, what it will, the verses should be easy, natural, and flowing, and contain a certain harmony, so that poetry and music may be agreeably united. In these compositions, as in all others, obscene and profane expressions should be carefully avoided, and indeed every thing that tends to take off that respect which is due to religion and virtue, and to encourage vice and immorality. As the best songs in our language are already in every hand, it would seem superfluous to insert examples. For further precepts, however, as well as select examples, in this species of composition, we may refer the reader to the elegant *Essay on Song Writing*, by Mr Aikin.

II. The *lesser ode*. The distinguishing character of this is sweetness; and as the pleasure we receive from this sort of poem arises principally from its soothing and affecting the passions, great regard should be paid to the language as well as to the thoughts and numbers.

Th' expression should be easy, fancy high;
Yet that not seem to creep, nor this to fly:
No words transpos'd, but in such order all,
As, though hard wrought, may seem by chance to fall.

D. Buckingham's Essay.

The style, indeed, should be easy: but it may be also florid and figurative. It solicits delicacy, but disdains affectation. The thoughts should be natural, chaste, and elegant; and the numbers various, smooth, and harmonious. A few examples will sufficiently explain what we mean.

Longinus has preserved a fragment of Sappho, an ancient Greek poetess, which is in great reputation amongst the critics, and has been so happily translated by Mr Philips as to give the English reader a just idea of the spirit, ease, and elegance of that admired author; and show how exactly she copied nature. To enter into the beauties of this ode, we must suppose a lover sitting by his mistress, and thus expressing his passion:

Blest as th' immortal gods is he,
The youth who fondly sits by thee,
And sees and hears thee all the while
Softly speak, and sweetly smile.
'Twas this depriv'd my soul of rest,
And rais'd such tumults in my breast;
For while I gaz'd, in transport tost,
My breath was gone, my voice was lost.
My bosom glow'd, the subtle flame
Ran quick through all my vital frame:
O'er my dim eyes a darkness hung;
My ears with hollow murmurs rung.
In dewy damps my limbs were chill'd;
My blood with gentle horrors thrill'd;
My feeble pulse forgot to play;
I fainted, sunk, and dy'd away.

After this instance of the Sapphic ode, it may not be improper to speak of that sort of ode which is called *Anacreontic*; being written in the manner and taste of Anacreon, a Greek poet, famous for the delicacy of his wit, and the exquisite, yet easy and natural, turn of his poesy. We have several of his odes still extant, and many modern ones in imitation of him, which are mostly composed in verses of seven syllables, or three feet and a half.

We shall give the young student one or two examples of his manner from Mr Fawkes's excellent translation.

yric ry. The following ode on the power of gold, which had been often attempted but with little succefs, this gentleman has tranflated very happily.

Love's a pain that works our wo;
Not to love is painful too:
But, alas! the greateft pain
Waits the love that meets difdain.
What avails ingenuous worth,
Sprightly wit, or noble birth?
All thefe virtues ufelefs prove;
Gold alone engages love.
May he be completely curft,
Who the fleeping mifchief firft
Wak'd to life, and, vile before,
Stamp'd with worth the fordid ore.
Gold creates in brethren ftrife;
Gold deftroys the parent's life;
Gold produces civil jars,
Murders, maffacres, and wars;
But the worft effect of gold,
Love, alas! is bought and fold.

His ode on the vanity of riches is of a piece with the above, and conveys a good leffon to thofe who are over anxious for wealth.

If the treafur'd gold could give
Man a longer term to live,
I'd employ my utmoft care
Still to keep, and ftill to fpare;
And, when death approach'd, would fay,
'Take thy fee, and walk away.'
But fince riches cannot fave
Mortals from the gloomy grave,
Why fhould I myfelf deceive,
Vainly figh, and vainly grieve?
Death will furely be my lot,
Whether I am rich or not.
Give me freely while I live
Generous wines, in plenty give
Soothing joys my life to cheer,
Beauty kind, and friends fincere;
Happy! could I ever find
Friends fincere, and beauty kind.

But two of the moft admired, and perhaps the moft imitated, of Anacreon's odes, are that of Mars wounded by one of the darts of Love, and Cupid ftung by a Bee; both which are wrought up with fancy and delicacy, and are tranflated with elegance and fpirit.—Take that of Cupid ftung by a bee.

Once as Cupid, tir'd with play,
On a bed of rofes lay,
A rude bee, that flept unfeen,
The fweet breathing buds between,
Stung his finger, cruel chance!
With its little pointed lance.
Straight he fills the air with cries,
Weeps, and fobs, and runs, and flies;
'Till the god to Venus came,
Lovely, laughter-loving dame:
Then he thus began to plain;
"Oh! undone——I die with pain——
"Dear mamma, a ferpent fmall,
"Which a bee the ploughmen call,
"Imp'd with wings, and arm'd with dart,
"Oh!—has ftung me to the heart."
Venus thus reply'd, and fmil'd:
'Dry thofe tears for fhame! my child;
'If a bee can wound fo deep,
'Caufing Cupid thus to weep,
'Think, O think! what cruel pains
'He that's ftung by thee fuftains.'

Of Lyric Poetry.

124 Imitations of Anacreon and

Among the moft fuccefsful of this poet's Englifh imitators may be reckoned Dr Johnfon and Mr Prior. The following ode on *Evening* by the former of thefe writers has, if we miftake not, the very fpirit and air of Anacreon.

Evening now from purple wings
Sheds the grateful gifts fhe brings;
Brilliant drops bedeck the mead;
Cooling breezes fhake the reed;
Shake the reed, and curl the ftream
Silver'd o'er with Cynthia's beam;
Near the chequer'd lonely grove
Hears, and keeps thy fecrets, Love.
Stella, thither let us ftray!
Lightly o'er the dewy way.
Phœbus drives his burning car
Hence, my lovely Stella, far:
In his ftead the queen of night
Round us pours a lambent light;
Light that feems but juft to fhow
Breafts that beat, and cheeks that glow:
Let us now, in whifper'd joy,
Evening's filent hours employ;
Silence beft, and confcious fhades,
Pleafe the hearts that love invades:
Other pleafures give them pain;
Lovers all but love difdain.

But of all the imitations of the playful bard of Greece that we have ever met with, the moft perfect is the following Anacreontic by the regent Duke of Orleans.

I.

Je fuis né pour les plaifirs;
Bien fou qui s'en paffe:
Je ne veux pas les choifir;
Souvent le choix m'embarraffe:
Aime t'on? J'aime foudain;
Bois t'on? J'ai le verre à la main;
Je tiens par tout ma place.

II.

Dormir eft un temps perdu;
Faut il qu'on s'y livre?
Sommeil, prends ce qui t'eft du;
Mais attends que je fois yvre:
Saifis moi dans cet inftant;
Fais moi dormir promptement;
Je fuis preffé de vivre.

III.

Mais fi quelque objet charmant,
Dans un fonge aimable,
Vient d'un plaifir feduifant
M'offrir l'image agréable;
Sommeil, allons doucement;
L'erreur eft en ce moment
Un bonheur veritable.

Tranflation

Of Lyric Poetry.

Tranſlation of the Regent's Anacreontic (E).

Frolic and free, for pleaſure born,
The ſelf-denying fool I ſcorn:
The proffer'd joy I ne'er refuſe;
'Tis oft-times troubleſome to chuſe.
Lov'ſt thou, my friend? I love at ſight:
Drink'ſt thou? this bumper does thee right.
At random with the ſtream I flow,
And play my part where'er I go.

Great God of Sleep, ſince we muſt be
Oblig'd to give ſome hours to thee,
Invade me not till the full bowl
Glows in my cheek, and warms my ſoul.
Be *that* the only time to ſnore,
When I can love and drink no more:
Short, very ſhort, then be thy reign;
For I'm in haſte to live again.

But, O! if melting in my arms,
In ſome ſoft dream, with all her charms,
The nymph belov'd ſhould then ſurpriſe,
And grant what waking ſhe denies;
Then prithee, gentle Slumber, ſtay;
Slowly, ah ſlowly, bring the day:
Let no rude noiſe my bliſs deſtroy;
Such ſweet deluſion's real joy.

125 Sappho. We have mentioned Prior as an imitator of Anacreon; but the reader has by this time had a ſufficient ſpecimen of Anacreontics. The following *Anſwer to Cloe jealous*, which was written when Prior was ſick, has much of the elegant tenderneſs of Sappho.

Yes, faireſt proof of beauty's pow'r,
Dear idol of my panting heart,
Nature points this my fatal hour:
And I have liv'd: and we muſt part.
While now I take my laſt adieu,
Heave thou no ſigh, nor ſhed a tear;
Leſt yet my half-clos'd eye may view
On earth an object worth its care.
From jealouſy's tormenting ſtrife
For ever be thy boſom freed;
That nothing may diſturb thy life,
Content I haſten to the dead.
Yet when ſome better-fated youth
Shall with his am'rous parly move thee,
Reflect one moment on his truth
Who, dying, thus perſiſts to love thee.

There is much of the ſoftneſs of Sappho, and the ſweetneſs of Anacreon and Prior, in the following ode, which is aſcribed to the late unfortunate Dr Dodd; and was written in compliment to a lady, who, being ſick, had ſent the author a moſs roſe-bud, inſtead of making his family a viſit. This piece is particularly to be eſteemed for the juſt and ſtriking moral with which it is pointed.

The ſlighteſt of favours beſtow'd by the fair,
With rapture we take, and with triumph we wear:
But a moſs-woven roſe-bud, Eliza, from thee,
A well-pleaſing gift to a monarch would be.
—Ah! that illneſs, too cruel, forbidding ſhould ſtand,
And refuſe me the gift from thy own lovely hand!
With joy I receive it, with pleaſure will view,
Reminded of thee, by its odour and hue:
"Sweet roſe, let me tell thee, tho' charming thy bloom,
Tho' thy fragrance excels Seba's richeſt perfume;
Thy breath to Eliza's no fragrance hath in't,
And but dull is thy bloom to her cheek's bluſhing tint.
Yet, alas! my fair flow'r, that bloom will decay,
And all thy lov'd beauties ſoon wither away;
Tho' pluck'd by her hand, to whoſe touch, we muſt own,
Harſh and rough is the cygnet's moſt delicate down:"
Thou too, ſnowy hand; nay, I mean not to preach;
But the roſe, lovely moraliſt, ſuffer to teach.
"Extol not, fair maiden, thy beauties o'er mine;
They too are ſhort-liv'd, and they too muſt decline;
And ſmall, in concluſion, the diff'rence appears,
In the bloom of few days, or the bloom of few years!
But remember a virtue the roſe hath to boaſt,
—Its fragrance remains when its beauties are loſt!"

126 Odes more florid and figurative. We come now to thoſe odes of the more florid and figurative kind, of which we have many in our language that deſerve particular commendation. Mr Warton's Ode to Fancy has been juſtly admired by the beſt judges; for though it has a diſtant reſemblance of Milton's L'Allegro and Il Penſeroſo, yet the work is original; the thoughts are moſtly new and various, and the language and numbers elegant, expreſſive, and harmonious.

O parent of each lovely muſe,
Thy ſpirit o'er my ſoul diffuſe!
O'er all my artleſs ſongs preſide,
My footſteps to thy temple guide!
To offer at thy turf-built ſhrine
In golden cups no coſtly wine,
No murder'd fatling of the flock,
But flow'rs and honey from the rock.
O nymph, with looſely flowing hair,
With buſkin'd leg, and boſom bare;
Thy waiſt with myrtle-girdle bound,
Thy brows with Indian feathers crown'd;
Waving in thy ſnowy hand
An all-commanding magic wand,
Of pow'r to bid freſh gardens blow
'Mid cheerleſs Lapland's barren ſnow:
Whoſe rapid wings thy flight convey,
Through air, and over earth and ſea;
While the vaſt various landſcape lies
Conſpicuous to thy piercing eyes.
O lover of the deſert, hail!
Say, in what deep and pathleſs vale,
Or on what hoary mountain's ſide,
'Midſt falls of water, you reſide;
'Midſt broken rocks, a rugged ſcene,
With green and graſſy dales between;
'Midſt foreſts dark of aged oak,
Ne'er echoing with the woodman's ſtroke;

Where

(E) We give this tranſlation, both becauſe of its excellence and becauſe it is ſaid to have been the production of no leſs a man than the late Lord Chatham.

Where never human art appear'd,
Nor ev'n one ftraw-roof'd cott was rear'd;
Where Nature feems to fit alone,
Majeftic on a craggy throne.
Tell me the path, fweet wand'rer! tell,
To thy unknown fequefter'd cell,
Where woodbines clufter round the door,
Where fhells and mofs o'erlay the floor,
And on whofe top an hawthorn blows,
Amid whofe thickly-woven boughs
Some nightingale ftill builds her neft,
Each ev'ning warbling thee to reft.
Then lay me by the haunted ftream,
Wrapt in fome wild poetic dream;
In converfe while methinks I rove
With Spenfer through a fairy grove;
Till fuddenly awak'd, I hear
Strange whifper'd mufic in my ear;
And my glad foul in blifs is drown'd
By the fweetly foothing found!
Me, goddefs, by the right-hand lead,
Sometimes through the yellow mead;
Where Joy and white-rob'd Peace refort,
And Venus keeps her feftive court;
Where Mirth and Youth each ev'ning meet,
And lightly trip with nimble feet,
Nodding their lily-crowned heads,
Where Laughter rofe-lip'd Hebe leads;
Where Echo walks fteep hills among,
Lift'ning to the fhepherd's fong.
Yet not thefe flow'ry fields of joy
Can long my penfive mind employ;
Hafte, Fancy, from the fcenes of Folly,
To meet the matron Melancholy!
Goddefs of the tearful eye,
That loves to fold her arms and figh.
Let us with filent footfteps go
To charnels, and the houfe of wo;
To Gothic churches, vaults, and tombs,
Where each fad night fome virgin comes,
With throbbing breaft and faded cheek,
Her promis'd bridegroom's urn to feek:
Or to fome abbey's mould'ring tow'rs,
Where, to avoid cold wint'ry fhow'rs,
The naked beggar fhivering lies,
While whiftling tempefts round her rife,
And trembles left the tott'ring wall
Should on her fleeping infants fall.
   Now let us louder ftrike the lyre,
For my heart glows with martial fire;
I feel, I feel, with fudden heat,
My big tumultuous bofom beat;
The trumpet's clangors pierce my ear,
A thoufand widows fhrieks I hear:
Give me another horfe, I cry;
Lo, the bafe Gallic fquadrons fly!
Whence is this rage?—what fpirit, fay,
To battle hurries me away?
'Tis Fancy, in her fiery car,
Tranfports me to the thickeft war;
There whirls me o'er the hills of flain,
Where tumult and deftruction reign;
Where, mad with pain, the wounded fteed,
Tramples the dying and the dead;
Where giant Terror ftalks around,
With fullen joy furveys the ground,
And, pointing to th' enfanguin'd field,
Shakes his dreadful gorgon fhield!
O guide me from this horrid fcene
To high-arch'd walks and alleys green,
Which lovely Laura feeks, to fhun
The fervors of the mid-day fun.
The pangs of abfence, O remove,
For thou can'ft place me near my love;
Can'ft fold in vifionary blifs,
And let me think I fteal a kifs;
While her ruby lips difpenfe
Lufcious nectar's quinteffence!
When young-ey'd Spring profufely throws
From her green lap the pink and rofe;
When the foft turtle of the dale
To Summer tells her tender tale;
When Autumn cooling caverns feeks,
And ftains with wine his jolly cheeks;
When Winter, like poor pilgrim old,
Shakes his filver beard with cold;
At ev'ry feafon let my ear
Thy folemn whifpers, Fancy, hear.
O warm enthufiaftic maid!
Without thy powerful, vital aid,
That breathes an energy divine,
That gives a foul to ev'ry line,
Ne'er may I ftrive with lips profane,
To utter an unhallow'd ftrain;
Nor dare to touch the facred ftring,
Save when with fmiles thou bid'ft me fing.
O hear our pray'r, O hither come
From thy lamented Shakefpeare's tomb,
On which thou lov'ft to fit at eve,
Mufing o'er thy darling's grave.
O queen of numbers, once again
Animate fome chofen fwain,
Who, fill'd with unexhaufted fire,
May boldly fmite the founding lyre;
Who with fome new, unequall'd fong,
May rife above the rhyming throng;
O'er all our lift'ning paffions reign,
O'erwhelm our fouls with joy and pain;
With terror fhake, with pity move,
Rouze with revenge, or melt with love.
O deign t'attend his evening walk,
With him in groves and grottoes talk;
Teach him to fcorn, with frigid art,
Feebly to touch th' enraptur'd heart;
Like lightning, let his mighty verfe
The bofom's inmoft foldings pierce;
With native beauties win applaufe,
Beyond cold critics ftudied laws:
O let each mufe's fame increafe!
O bid Britannia rival Greece!

The following ode, written by Mr Smart on the 5th of December (being the birth-day of a beautiful young lady), is much to be admired for the variety and harmony of the numbers, as well as for the beauty of the thoughts, and the elegance and delicacy of the compliment. It has great fire, and yet great fweetnefs, and is the happy iffue of genius and judgment united.

 Hail

Of Lyric Poetry.

Hail eldeſt of the monthly train,
Sire of the winter drear,
December! in whoſe iron reign
Expires the chequer'd year.
Huſh all the bluſt'ring blaſts that blow,
And proudly plum'd in ſilver ſnow,
Smile gladly on this bleſt of days;
The livery'd clouds ſhall on thee wait,
And Phœbus ſhine in all his ſtate
With more than ſummer rays.
Though jocund June may juſtly boaſt
Long days and happy hours;
Though Auguſt be Pomona's hoſt,
And May be crown'd with flow'rs:
Tell June his fire and crimſon dies,
By Harriot's bluſh, and Harriot's eyes,
Eclips'd and vanquiſh'd, fade away;
Tell Auguſt, thou canſt let him ſee
A richer, riper fruit than he,
A ſweeter flow'r than May.

127 A paſtoral and elegiac ode.

The enſuing ode, written by Mr Collins on the death of Mr Thomſon, is of the paſtoral and elegiac kind, and both picturesque and pathetic. To perceive all the beauties of this little piece, which are indeed many, we muſt ſuppoſe them to have been delivered on the river Thames near Richmond.

In yonder grave a Druid lies,
Where ſlowly winds the ſtealing wave;
The year's beſt ſweets ſhall duteous riſe
To deck its poet's ſilvan grave!
In yon deep bed of whiſp'ring reeds
His airy harp * ſhall now be laid,
That he, whoſe heart in ſorrow bleeds,
May love through life the ſoothing ſhade.
Then maids and youths ſhall linger here,
And, while its ſounds at diſtance ſwell,
Shall ſadly ſeem in pity's ear
To hear the woodland pilgrim's knell.
Remembrance oft ſhall haunt the ſhore,
When Thames in ſummer wreaths is dreſt,
And oft ſuſpend the daſhing oar,
To bid his gentle ſpirit reſt!
And oft as eaſe and health retire
To breezy lawn, or foreſt deep,
The friend ſhall view yon whitening ſpire †,
And 'mid the varied landſcape weep.
But thou, who own'ſt that earthy bed,
Ah! what will ev'ry dirge avail?
Or tears, which love and pity ſhed,
That mourn beneath the gliding ſail?
Yet lives there one, whoſe heedleſs eye,
Shall ſcorn thy pale ſhrine glimm'ring near?
With him, ſweet bard, may fancy die,
And joy deſert the blooming year.
But thou, lorn ſtream, whoſe ſullen tide
No ſedge-crown'd ſiſters now attend,
Now waft me from the green hill's ſide,
Whoſe cold turf hides the buried friend.
And ſee, the fairy valleys fade,
Dim night has veil'd the ſolemn view!
Yet once again, dear parted ſhade,
Meek nature's child, again adieu!
The genial meads, aſſign'd to bleſs
Thy life, ſhall mourn thy early doom;
Their hinds, and ſhepherd girls, ſhall dreſs,
With ſimple hands, thy rural tomb.
Long, long, thy ſtone and pointed clay
Shall melt the muſing Briton's eyes;
O vales and wild woods, ſhall he ſay,
In yonder grave your Druid lies!

* The harp of Æolus.

† Richmond-church.

128 The hymn.

Under this ſpecies of the ode, notice ought to be taken of thoſe written on divine ſubjects, and which are uſually called *hymns*. Of theſe we have many in our language, but none perhaps that are ſo much admired as Mr Addiſon's. The beauties of the following hymn are too well known, and too obvious, to need any commendation; we ſhall only obſerve, therefore, that in this hymn (intended to diſplay the power of the Almighty) he ſeems to have had a pſalm of David in his view, which ſays, that "the heavens declare the glory of God, and the firmament ſheweth his handywork."

The ſpacious firmament on high,
With all the blue etherial ſky,
And ſpangled heav'ns, a ſhining frame,
Their great original proclaim:
Th' unwearied ſun, from day to day,
Does his Creator's pow'r diſplay,
And publiſhes to ev'ry land
The work of an Almighty hand.
Soon as the ev'ning ſhades prevail,
The moon takes up the wond'rous tale,
And nightly to the liſt'ning earth
Repeats the ſtory of her birth:
While all the ſtars that round her burn,
And all the planets in their turn,
Confirm the tidings as they roll,
And ſpread the truth from pole to pole.
What tho' in ſolemn ſilence all
Move round the dark terreſtrial ball?
What tho' nor real voice or ſound
Amid their radiant orb be found?
In reaſon's ear they all rejoice,
And utter forth a glorious voice,
For ever ſinging, as they ſhine,
"The hand that made us is divine."

The following paſtoral hymn is a verſion of the 23d *Pſalm* by Mr Addiſon; the peculiar beauties of which have occaſioned many tranſlations; but we have ſeen none that is ſo poetical and perfect as this. And in juſtice to Dr Boyce, we muſt obſerve, that the muſic he has adapted to it is ſo ſweet and expreſſive, that we know not which is to be moſt admired, the poet or the muſician.

The Lord my paſture ſhall prepare,
And feed me with a ſhepherd's care;
His preſence ſhall my wants ſupply,
And guard me with a watchful eye;
My noon-day walks he ſhall attend,
And all my midnight hours defend.
When in the ſultry glebe I faint,
Or on the thirſty mountain pant,
To fertile vales and dewy meads
My weary wand'ring ſteps he leads;
Where peaceful rivers ſoft and ſlow
Amid the verdant landſcape flow.
Tho' in the paths of death I tread,
With gloomy horrors overſpread,

yric
try.

My ſteadfaſt heart ſhall fear no ill:
For thou, O Lord, art with me ſtill;
Thy friendly crook ſhall give me aid,
And guide me through the dreadful ſhade.
Tho' in a bare and rugged way,
Through devious lonely wilds I ſtray,
Thy bounty ſhall my pains beguile:
The barren wilderneſs ſhall ſmile,
With ſudden greens and herbage crown'd;
And ſtreams ſhall murmur all around.

29 ſub- ode. III. We are now to ſpeak of thoſe odes which are of the ſublime and noble kind, and diſtinguiſhed from others by their elevation of thought and diction, as well by the variety or irregularity of their numbers as the frequent tranſitions and bold excurſions with which they are enriched.

To give the young ſtudent an idea of the ſudden and frequent tranſitions, digreſſions, and excurſions, which are admitted into the odes of the ancients, we cannot do better than refer him to the celebrated ſong or ode of Moſes; which is the oldeſt that we know of, and was penned by that divine author immediately after the children of Iſrael croſſed the Red-Sea.

At the end of this ſong, we are told, that "Miriam the propheteſs, the ſiſter of Aaron, took a timbrel in her hand, and all the women went out after her with timbrels and with dances. And Miriam anſwered them, Sing ye to the Lord, for he hath triumphed gloriouſly; the horſe and his rider hath he thrown into the ſea."

From this laſt paſſage it is plain, that the ancients very early called in muſic to the aid of poetry; and that their odes were uſually ſung, and accompanied with their lutes, harps, lyres, timbrels, and other inſtruments: nay, ſo eſſential, and in ſuch reputation, was muſic held by the ancients, that we often find in their lyric poets, addreſſes or invocations to the harp, the lute, or the lyre; and it was probably owing to the frequent uſe made of the laſt-mentioned inſtrument with the ode, that this ſpecies of writing obtained the name of *Lyric poetry*.

This ode, or hymn, which ſome believe was compoſed by Moſes in Hebrew verſe, is incomparably better than any thing the heathen poets have produced of the kind, and is by all good judges conſidered as a maſter-piece of ancient eloquence. The thoughts are noble and ſublime: the ſtyle is magnificent and expreſſive: the figures are bold and animated: the tranſitions and excurſions are ſudden and frequent: but they are ſhort, and the poet, having digreſſed for a moment, returns immediately to the great object that excited his wonder, and elevated his ſoul with joy and gratitude. The images fill the mind with their greatneſs, and ſtrike the imagination in a manner not to be expreſſed.

If there be any thing that in ſublimity approaches to it, we muſt look for it in the eaſt, where perhaps we ſhall find nothing ſuperior to the following Hindoo hymn to *Narrayna*, or "the ſpirit of God," taken, as Sir William Jones informs us, from the writings of the ancient Bramins.

Of Lyric Poetry.

Spirit of ſpirits, who, through every part
Of ſpace expanded, and of endleſs time,
Beyond the reach of lab'ring thought ſublime,
Badſt uproar into beauteous order ſtart;
Before heav'n was, thou art.
Ere ſpheres beneath us roll'd, or ſpheres above,
Ere earth in firmamental æther hung,
Thou ſat'ſt alone, till, through thy myſtic love,
Things unexiſting to exiſtence ſprung,
And grateful deſcant ſung.
Omniſcient Spirit, whoſe all-ruling pow'r
Bids from each ſenſe bright emanations beam;
Glows in the rainbow, ſparkles in the ſtream,
Smiles in the bud, and gliſten's in the flow'r
That crowns each vernal bow'r;
Sighs in the gale, and warbles in the throat
Of every bird that hails the bloomy ſpring,
Or tells his love in many a liquid note,
Whilſt envious artiſts touch the rival ſtring,
Till rocks and foreſts ring;
Breathes in rich fragrance from the Sandal grove,
Or where the precious muſk-deer playful rove;
In dulcet juice, from cluſt'ring fruit diſtils,
And burns ſalubrious in the taſteful clove:
Soft banks and verd'rous hills
Thy preſent influence fills;
In air, in floods, in caverns, woods, and plains,
Thy will inſpirits all, thy ſovereign Maya reigns.
Blue cryſtal vault, and elemental fires,
That in th' ethereal fluid blaze and breathe;
Thou, toſſing main, whoſe ſnaky branches wreathe
This penſile orb with intertwiſting gyres;
Mountains, whoſe lofty ſpires,
Preſumptuous, rear their ſummits to the ſkies,
And blend their em'rald hue with ſapphire light;
Smooth meads and lawns, that glow with varying dyes
Of dew-beſpangled leaves and bloſſoms bright,
Hence! vaniſh from my ſight
Deluſive pictures! unſubſtantial ſhows!
My ſoul abſorb'd one only Being knows,
Of all perceptions one abundant ſource,
Whence ev'ry object, ev'ry moment flows:
Suns hence derive their force,
Hence planets learn their courſe;
But ſuns and fading worlds I view no more;
God only I perceive; God only I adore (F).

We come now to the *Pindaric ode*, which (if we except the hymns in the Old Teſtament, the pſalms of king David, and ſuch hymns of the Hindoos as that juſt quoted) is the moſt exalted part of Lyric poetry; and was ſo called from *Pindar*, an ancient Greek poet, who is celebrated for the boldneſs of his flights, the impetuoſity of his ſtyle, and the ſeeming wildneſs and irregularity that runs through his compoſitions, and which are ſaid to be the effect of the greateſt art. See PINDAR. 130 The Pindaric ode.

The odes of Pindar were held in ſuch high eſtimation by the ancients, that it was fabled, in honour of their ſweetneſs, that the bees, while he was in the cradle, brought

(F) For the philoſophy of this ode, which repreſents the Deity as the ſoul of the world, or rather as the only Being (the τὸ ἓν of the Greeks), ſee METAPHYSICS, n° 269, and PHILOSOPHY, n° 6.

brought honey to his lips: nor did the victors at the Olympic and other games think the crown a sufficient reward for their merit, unless their atchievements were celebrated in Pindar's songs; most wisely presaging, that the first would decay, but the other endure for ever.

This poet did not always write his odes in the same measure, or with the same intention with regard to their being sung. For the ode inscribed to Diagoras (the concluding stanza of which we inserted at the beginning of this section) is in heroic measure, and all the stanzas are equal: there are others also, as Mr West observes, made up of *strophes* and *antistrophes*, without any *epode*; and some composed of *strophes* only, of different lengths and measures: but the greatest part of his odes are divided into *strophe*, *antistrophe*, and *epode*; in order, as Mr Congreve conjectures, to their being sung, and addressed by the performers to different parts of the audience. "They were sung (says he) by a chorus, and adapted to the lyre, and sometimes to the lyre and pipe. They consisted oftenest of three stanzas. The first was called the *strophe*, from the version or circular motion of the singers in that stanza from the right hand to the left. The second stanza was called the *antistrophe*, from the contraversion of the chorus; the singers in performing that, turning from the left hand to the right, contrary always to their motion in the *strophe*. The third stanza was called the *epode* (it may be as being the after-song), which they sung in the middle, neither turning to one hand nor the other. But Dr West's* friend is of opinion, that the performers also danced one way while they were singing the *strophe*, and danced back as they sung the *antistrophe*, till they came to the same place again, and then standing still they sung the *epode*. He has translated a passage from the *Scholia* on *Hephæstion*, in proof of his opinion; and observes, that the dancing the *strophe* and *antistrophe* in the same space of ground, and we may suppose the same space of time also, shows why those two parts consisted of the same length and measure.

*Vid. *Pref. to West's Pindar.*

As the various measures of Pindar's odes have been the means of so far misleading some of our modern poets, as to induce them to call compositions Pindaric odes, that were not written in the method of Pindar, it is necessary to be a little more particular on this head, and to give an example from that poet, the more effectually to explain his manner; which we shall take from the translation of Dr West.

The eleventh NEMEAN ODE.

This ode is inscribed to Aristagoras, upon occasion of his entering on his office of president or governor of the island of Tenedos: so that, although it is placed among the Nemean odes, it has no sort of relation to those games, and is indeed properly an inauguration ode, composed to be sung by a chorus at the sacrifices and the feasts made by Aristagoras and his colleagues, in the town-hall, at the time of their being invested with the magistracy, as is evident from many expressions in the first *strophe* and *antistrophe*.

ARGUMENT.

Pindar opens this ode with an invocation to Vesta (the goddess who presided over the courts of justice, and whose statue and altar were for that reason placed in the town-halls, or *Prytanæums*, as the Greeks called them), beseeching her to receive favourably Aristagoras and his colleagues, who were then coming to offer sacrifices to her, upon their entering on their office of Prytans or magistrates of Tenedos; which office continuing for a year, he begs the goddess to take Aristagoras under her protection during that time, and to conduct him to the end of it without trouble or disgrace. From Aristagoras, Pindar turns himself in the next place to his father Arcesilas, whom he pronounces happy, as well upon account of his son's merit and honour, as upon his own great endowments and good fortune; such as beauty, strength, courage, riches, and glory, resulting from his many victories in the games. But lest he should be too much puffed up with these praises, he reminds him at the same time of his mortality, and tells him that his clothing of flesh is perishable, that he must e'er long be clothed with earth, the *end of all things*: and yet, continues he, it is but justice to praise and celebrate the worthy and deserving, who from good citizens ought to receive all kinds of honour and commendation; as Aristagoras, for instance, who hath rendered both himself and his country illustrious by the many victories he hath obtained, to the number of sixteen, over the neighbouring youth, in the games exhibited in and about his own country. From whence, says the poet, I conclude he would have come off victorious even in the Pythian and Olympic games, had he not been restrained from engaging in those famous lists by the too timid and cautious love of his parents. Upon which he falls into a moral reflection upon the vanity of man's hopes and fears; by the former of which they are oftentimes excited to attempts beyond their strength, which accordingly issue in their disgrace; as, on the other hand, they are frequently restrained, by unreasonable and ill-grounded fears, from enterprises, in which they would in all probability have come off with honour. This reflection he applies to Aristagoras, by saying it was very easy to foresee what success he was like to meet with, who both by father and mother was descended from a long train of great and valiant men. But here again, with a very artful turn of flattery to his father Arcesilas, whom he had before represented as strong and valiant, and famous for his victories in the games, he observes that every generation, even of a great and glorious family, is not equally illustrious any more than the fields and trees are every year equally fruitful; that the gods had not given mortals any certain tokens by which they might foreknow when the *rich years of virtue should succeed*; whence it comes to pass, that men, out of self-conceit and presumption, are perpetually laying schemes, and forming enterprises, without previously consulting prudence or wisdom, whose *streams*, says he, lie remote and out of the common road. From all which he infers, that it is better to moderate our desires, and set bounds to our avarice and ambition; with which moral precept he concludes the ode.

STROPHE I.

Daughter of Rhea! thou, whose holy fire
Before the awful seat of justice flames!
Sister of heav'n's almighty sire!
Sister of Juno, who coequal claims
With Jove to share the empire of the gods!
O virgin Vesta! to thy dread abodes,

Lo!

Of Lyric Poetry.

Lo! Ariſtagoras directs his pace!
Receive and near thy ſacred ſceptre place
Him, and his colleagues, who, with honeſt zeal,
O'er Tenedos preſide, and guard the public weal.

ANTISTROPHE I.

And lo! with frequent off'rings, they adore
Thee*, firſt invok'd in ev'ry ſolemn pray'r!
To thee unmix'd libations pour,
And fill with od'rous fumes the fragrant air.
Around in feſtive ſongs the hymning choir
Mix the melodious voice and ſounding lyre,
While ſtill, prolong'd with hoſpitable love,
Are ſolemniz'd the rites of genial Jove:
Then guard him, Veſta, through his long career,
And let him cloſe in joy his miniſterial year.

EPODE I.

But hail, Arceſilas! all hail
To thee, bleſs'd father of a ſon ſo great!
Thou whom on fortune's higheſt ſcale
The favourable hand of heav'n hath ſet,
Thy manly form with beauty hath refin'd,
And match'd that beauty with a valiant mind.
Yet let not man too much preſume,
Tho' grac'd with beauty's faireſt bloom;
Tho' for ſuperior ſtrength renown'd;
Tho' with triumphal chaplets crown'd:
Let him remember, that, in fleſh array'd,
Soon ſhall he ſee that mortal veſtment fade;
Till loſt, impriſon'd in the mould'ring urn,
To earth, the end of all things, he return.

STROPHE II.

Yet ſhould the worthy from the public tongue
Receive their recompenſe of virtuous praiſe;
By ev'ry zealous patriot ſung,
And deck'd with ev'ry flow'r of heav'nly lays.
Such retribution in return for fame,
Such, Ariſtagoras, thy virtues claim,
Claim from thy country; on whoſe glorious brows
The wreſtler's chaplet ſtill unfaded blows;
Mix'd with the great Pancratiaſtic crown,
Which from the neighb'ring youth thy early valour won.

ANTISTROPHE II.

And (but his timid parents' cautious love,
Diſturbing ever his too forward hand,
Forbad their tender ſon to prove
The toils of Pythia or Olympia's ſands),
Now by the Gods I ſwear, his valorous might
Had 'ſcap'd victorious in each bloody fight;
And from Caſtalia†, or where dark with ſhade
The mount of Saturn ‡ rears its olive head,
Great and illuſtrious home had he return'd;
While, by his fame eclips'd, his vanquiſh'd foes had [mourn'd.

EPODE II.

Then his triumphal treſſes bound
With the dark verdure of th' Olympic grove,
With joyous banquets had he crown'd
The great quinquennial feſtival of Jove;
And cheer'd the ſolemn pomp with choral lays,
Sweet tribute, which the muſe to virtue pays.

But, ſuch is man's prepoſt'rous fate!
Now, with o'er-weening pride elate,
Too far he aims his ſhaft to throw,
And ſtraining burſts his feeble bow:
Now puſillanimous depreſs'd with fear,
He checks his virtue in the mid career;
And of his ſtrength diſtruſtful, coward flies
The conteſt, tho' empow'rd to gain the prize.

STROPHE III.

But who could err in propheſying good
Of him, whoſe undegenerating breaſt
Swells with a tide of Spartan blood,
From fire to fire in long ſucceſſion trac'd
Up to Piſander; who in days of yore
From old Amyclæ to the Leſbian ſhore
And Tenedos, colleagu'd in high command
With great Oreſtes, led th' Æolian band?
Nor was his mother's race leſs ſtrong and brave,
Sprung from a ſtock that grew on fair* Iſmenus' wave.

* Iſmenus was a river of Bœotia, of which country was Menalippus, the anceſtor of Ariſtagoras by the mother's ſide.

ANTISTROPHE III.

Tho' for long intervals obſcur'd, again
Oft-times the ſeeds of lineal worth appear.
For neither can the furrow'd plain
Full harveſts yield with each returning year;
Nor in each period will the pregnant bloom
Inveſt the ſmiling tree with rich perfume.
So, barren often, and inglorious, paſs
The generations of a noble race;
While nature's vigour, working at the root,
In after-ages ſwells, and bloſſoms into fruit.

EPODE III.

Nor hath Jove giv'n us to foreknow
When the rich years of virtue ſhall ſucceed:
Yet bold and daring on we go,
Contriving ſchemes of many a mighty deed;
While hope, fond inmate of the human mind,
And ſelf-opinion, active, raſh, and blind,
Hold up a falſe illuſive ray,
That leads our dazzled feet aſtray
Far from the ſprings, where, calm and ſlow,
The ſecret ſtreams of wiſdom flow.
Hence ſhould we learn our ardour to reſtrain,
And limit to due bounds the thirſt of gain.
To rage and madneſs oft that paſſion turns,
Which with forbidden flames deſpairing burns.

131 Diſtinguiſhing characters of it.

From the above ſpecimen, and from what we have already ſaid on this ſubject, the reader will perceive, that odes of this ſort are diſtinguiſhed by the happy tranſitions and digreſſions which they admit, and the ſurpriſing yet natural returns to the ſubject. This requires great judgment and genius; and the poet who would excel in this kind of writing, ſhould draw the plan of his poem, in manner of the argument we have above inſerted, and mark out the places where thoſe elegant and beautiful ſallies and wanderings may be made, and where the returns will be eaſy and proper.

Pindar, it is univerſally allowed, had a poetical and fertile imagination, a warm and enthuſiaſtic genius, a bold and figurative expreſſion, and a conciſe and ſententious ſtyle: but it is generally ſuppoſed that many of thoſe pieces which procured him ſuch extravagant

Of Lyric Poetry.

praises and extraordinary testimonies of esteem from the ancients are lost; and if they were not, it would be perhaps impossible to convey them into our language; for beauties of this kind, like plants of an odoriferous and delicate nature, are not to be transplanted into another clime without losing much of their fragrance or essential quality.

132 Modern odes commonly called Pindaric.

With regard to those compositions which are usually called *Pindaric odes*, (but which ought rather to be distinguished by the name of *irregular odes*), we have many in our language that deserve particular commendation: and the criticism Mr Congreve has given us on that subject, has too much asperity and too great latitude; for if other writers have, by mistaking Pindar's measures, given their odes an improper title, it is a crime, one would think, not so dangerous to the commonwealth of letters as to deserve such severe reproof. Beside which, we may suppose that some of these writers did not deviate from Pindar's method through ignorance, but by choice; and that as their odes were not to be performed with both singing and dancing, in the manner of Pindar's, it seemed unnecessary to confine the first and second stanzas to the same exact numbers as was done in his strophes and antistrophes. The poet therefore had a right to indulge himself with more liberty: and we cannot help thinking, that the ode which Mr Dryden has given us, intitled, *Alexander's Feast*, or *the Power of Music*, is altogether as valuable in loose and wild numbers, as it could have been if the stanzas were more regular, and written in the manner of Pindar. In this ode there is a wonderful sublimity of thought, a loftiness and sweetness of expression, and a most pleasing variety of numbers.

'Twas at the royal feast, for Persia won
By Philip's warlike son,
Aloft, in awful state,
The god-like hero sate
On his imperial throne:
His valiant peers were plac'd around:
Their brows with roses and with myrtles bound,
(So should desert in arms be crown'd:)
The lovely Thais by his side
Sat like a blooming eastern bride,
In flow'r of youth and beauty's pride,
Happy, happy, happy pair!
None but the brave,
None but the brave,
None but the brave deserve the fair.
Chor. *Happy, happy*, &c.

Timotheus, plac'd on high
Amid the tuneful quire,
With flying fingers touch'd the lyre:
The trembling notes ascend the sky,
And heav'nly joys inspire.
The song began from Jove,
Who left his blissful seats above,
(Such is the pow'r of mighty love!)
A dragon's fiery form bely'd the God:
Sublime on radiant spires he rode,
When he to fair Olympia press'd;
And while he sought her snowy breast:
Then round her slender waist he curl'd,
And stamp'd an image of himself, a sov'reign of the world.
The list'ning crowd admire the lofty sound.
A present deity, they shout around;
A present deity, the vaulted roofs rebound:
With ravish'd ears
The monarch hears,
Assumes the God,
Affects to nod,
And seems to shake the spheres.
Chor. *With ravish'd ears*, &c.

The praise of Bacchus then the sweet musician sung;
Of Bacchus ever fair and ever young:
The jolly God in triumph comes;
Sound the trumpets, beat the drums:
Flush'd with a purple grace,
He shows his honest face:
Now give the hautboys breath; he comes, he comes!
Bacchus, ever fair and young,
Drinking joys did first ordain:
Bacchus' blessings are a treasure,
Drinking is the soldier's pleasure:
Rich the treasure,
Sweet the pleasure:
Sweet the pleasure after pain.
Chor. *Bacchus' blessings*, &c.

Sooth'd with the sound, the king grew vain,
Fought all his battles o'er again;
And thrice he routed all his foes, and thrice he slew the slain.
The master saw the madness rise;
His glowing cheeks, his ardent eyes;
And while he heav'n and earth defy'd,
Chang'd his hand, and check'd his pride.
He chose a mournful muse
Soft pity to infuse:
He sung Darius great and good,
By too severe a fate,
Fallen, fallen, fallen, fallen,
Fallen from his high estate,
And welt'ring in his blood;
Deserted at his utmost need,
By those his former bounty fed,
On the bare earth expos'd he lies,
With not a friend to close his eyes.
With down-cast looks the joyless victor sat,
Revolving in his alter'd soul
The various turns of chance below;
And now and then a sigh he stole,
And tears began to flow.
Cho. *Revolving*, &c.

The mighty master smil'd to see
That love was in the next degree:
'Twas but a kindred sound to move;
For pity melts the mind to love,
Softly sweet, in Lydian measures:
Soon he sooth'd his soul to pleasures.
War, he sung, is toil and trouble;
Honour but an empty bubble,
Never ending, still beginning,
Fighting still, and still destroying.
If the world be worth thy winning,
Think, O think, it worth enjoying.
Lovely Thais sits beside thee,
Take the good the gods provide thee.
The many rend the skies with loud applause;
So love was crown'd, but music won the cause.
The prince, unable to conceal his pain,
Gaz'd

Of Lyric Poetry.

Gaz'd on the fair,
Who caus'd his care,
And ſigh'd and look'd, ſigh'd and look'd,
Sigh'd and look'd, and ſigh'd again:
At length with love and wine at once oppreſs'd,
The vanquiſh'd victor ſunk upon her breaſt.
Chor. *The prince*, &c.
Now ſtrike the golden lyre again;
A louder yet, and yet a louder ſtrain.
Break his bands of ſleep aſunder,
And rouſe him, like a rattling peal of thunder.
Hark! hark! the horrid ſound
Has rais'd up his head,
As awake from the dead,
And amaz'd he ſtares round.
Revenge, revenge, Timotheus cries,
See the furies ariſe:
See the ſnakes that they rear,
How they hiſs in their hair,
And the ſparkles that flaſh from their eyes;
Behold a ghaſtly band,
Each a torch in his hand!
Thoſe are Grecian ghoſts that in battle were ſlain,
And unbury'd remain,
Inglorious on the plain.
Give the vengeance due
To the valiant crew.
Behold how they toſs their torches on high,
How they point to the Perſian abodes,
And glitt'ring temples of their hoſtile gods.
The princes applaud with a furious joy;
And the king ſeiz'd a flambeau, with zeal to deſtroy;
Thais led the way
To light him to his prey,
And, like another Helen, ſhe fir'd another Troy.
Chor. *And the king ſeiz'd*, &c.
Thus long ago,
While organs yet were mute;
Timotheus, to his breathing flute,
And ſounding lyre,
Could ſwell the ſoul to rage, or kindle ſoft deſire.
At laſt divine Cecilia came,
Inventreſs of the vocal frame;
The ſweet enthuſiaſt, from her ſacred ſtore,
Enlarg'd the former narrow bounds,
And added length to ſolemn ſounds,
With nature's mother-wit, and arts unknown before.
Let old Timotheus yield the prize
Or both divide the crown;
He rais'd a mortal to the ſkies;
She drew an angel down.
Grand chor. *At laſt*, &c.

There is another poem by Dryden, on the death of Mrs Anne Killegrew, a young lady eminent for her ſkill in poetry and painting, which a great critic * has pronounced to be "undoubtedly the nobleſt ode that our language has ever produced." He owns, that as a whole it may perhaps be inferior to *Alexander's Feaſt;* but he affirms that the firſt ſtanza of it is ſuperior to any ſingle part of the other. This famous ſtanza, he ſays, flows with a torrent of enthuſiaſm: *Fervet immenſuſque ruit*. How far this criticiſm is juſt, the public muſt determine.

I.

Thou youngeſt virgin-daughter of the ſkies,
Made in the laſt promotion of the bleſs'd;
Whoſe palms, new-pluck'd from Paradiſe,
In ſpreading branches more ſublimely riſe,
Rich with immortal green above the reſt;
Whether, adopted to ſome neighb'ring ſtar,
Thou roll'ſt above us, in thy wand'ring race,
Or in proceſſion fix'd and regular,
Mov'd with the heav'n's majeſtic pace;
Or, call'd to more ſuperior bliſs,
Thou tread'ſt with ſeraphims the vaſt abyſs:
Whatever happy region is thy place,
Ceaſe thy celeſtial ſong a little ſpace;
Thou wilt have time enough for hymns divine,
Since heaven's eternal year is thine.
Hear then a mortal muſe thy praiſe rehearſe
In no ignoble verſe;
But ſuch as thy own voice did practiſe here,
When thy firſt fruits of poeſy were giv'n
To make thyſelf a welcome inmate there;
While yet a young probationer,
And candidate of heav'n.

II.

If by traduction came thy mind,
Our wonder is the leſs to find
A ſoul ſo charming from a ſtock ſo good;
Thy father was transfus'd into thy blood,
So wert thou born into a tuneful ſtrain,
An early, rich, and inexhauſted vein.
But if thy pre-exiſting ſoul
Was form'd at firſt with myriads more,
It did through all the mighty poets roll,
Who Greek or Latin laurels wore,
And was that Sappho laſt which once it was before.
If ſo, then ceaſe thy flight, O heaven-born mind!
Thou haſt no droſs to purge from thy rich ore,
Nor can thy ſoul a fairer manſion find,
Than was the beauteous frame ſhe left behind:
Return to fill or mend the choir of thy celeſtial kind.

III.

May we preſume to ſay, that, at thy birth,
New joy was ſprung in heav'n, as well as here on earth?
For ſure the milder planets did combine
On thy auſpicious horoſcope to ſhine,
An e'en the moſt malicious were in trine.
Thy brother-angels at thy birth
Strung each his lyre, and tun'd it high,
That all the people of the ſky
Might know a poeteſs was born on earth.
And then, if ever, mortal ears
Had heard the muſic of the ſpheres.
And if no cluſt'ring ſwarm of bees
On thy ſweet mouth diſtill'd their golden dew,
'Twas that ſuch vulgar miracles
Heav'n had not leiſure to renew:
For all thy bleſs'd fraternity of love
Solemniz'd there thy birth, and kept thy holy day above.

IV.

O gracious God! how far have we
Profan'd thy heav'nly gift of poeſy?
Made proſtitute and profligate the Muſe,
Debas'd to each obſcene and impious uſe,

Of Lyric Poetry.

Whose harmony was first ordain'd above
For tongues of angels, and for hymns of love?
O wretched we! why were we hurry'd down
This lubrique and adult'rate age,
(Nay added fat pollutions of our own)
T' increase the streaming ordures of the stage!
What can we say t'excuse our second fall?
Let this thy vestal, Heav'n, atone for all:
Her Arethusian stream remains unsoil'd,
Unmix'd with foreign filth, and undefil'd;
Her wit was more than man, her innocence a child.

V.

Art she had none, yet wanted none;
For nature did that want supply:
So rich in treasures of her own,
She might our boasted stores defy:
Such noble vigour did her verse adorn,
That it seem'd borrow'd where 'twas only born.
Her morals, too, were in her bosom bred,
By great examples daily fed,
What in the best of books, her father's life she read.
And to be read herself, she need not fear;
Each test, and every light, her Muse will bear,
Tho' Epictetus with his lamp were there.
E'en love (for love sometimes her Muse express'd)
Was but a lambent flame which play'd about her breast,
Light as the vapours of a morning dream,
So cold herself, while she such warmth express'd,
'Twas Cupid bathing in Diana's stream.

VI.

Born to the spacious empire of the Nine,
One would have thought she should have been content
To manage well that mighty government;
But what can young ambitious souls confine?
To the next realm she stretch'd her sway,
For *Painture* near adjoining lay,
A plenteous province and alluring prey.
A *Chamber of Dependencies* was fram'd,
(As conquerors will never want pretence,
When arm'd, to justify th' offence)
And the whole fief, in right of poetry, she claim'd.
The country open lay without defence:
For poets frequent inroads there had made,
And perfectly could represent
The shape, the face, with ev'ry lineament,
And all the large domains which the *dumb sister* sway'd.
All bow'd beneath her government,
Receiv'd in triumph wheresoe'er she went.
Her pencil drew whate'er her soul design'd,
And oft the happy draught surpass'd the image in her mind.
The sylvan scenes of herds and flocks,
And fruitful plains and barren rocks,
Of shallow brooks that flow'd so clear,
The bottom did the top appear;
Of deeper too, and ampler floods,
Which, as in mirrors, show'd the woods:
Of lofty trees, with sacred shades,
And perspectives of pleasant glades,
Where nymphs of brightest form appear,
And shaggy satyrs standing near,
Which them at once admire and fear.
The ruins too of some majestic piece,
Boasting the power of ancient Rome or Greece,
Whose statues, freezes, columns, broken lie,
And, though defac'd, the wonder of the eye;
What nature, art, bold fiction, e'er durst frame,
Her forming hand gave feature to the name.
So strange a concourse ne'er was seen before,
But when the peopl'd ark the whole creation bore.

VII.

The scene then chang'd, with bold erected look
Our martial king the sight with rev'rence struck:
For not content t'express his outward part
Her hand call'd out the image of his heart:
His warlike mind, his soul devoid of fear,
His high-designing thoughts were figur'd there,
As when, by magic, ghosts are made appear.
Our phœnix queen was pourtray'd too so bright,
Beauty alone could beauty take so right:
Her dress, her shape, her matchless grace,
Were all observ'd, as well as heav'nly face.
With such a peerless majesty she stands,
As in that day she took the crown from sacred hands;
Before a train of heroines was seen,
In beauty foremost, as in rank, the queen.
Thus nothing to her genius was denied,
But like a ball of fire the further thrown,
Still with a greater blaze she shone,
And her bright soul broke out on ev'ry side.
What next she had design'd, Heav'n only knows:
To such immod'rate growth her conquest rose,
That fate alone its progress could oppose.

VIII.

Now all those charms, that blooming grace,
The well proportion'd shape, and beauteous face,
Shall never more be seen by mortal eyes;
In earth the much lamented virgin lies.
Nor wit nor piety could fate prevent;
Nor was the cruel *Destiny* content
To finish all the murder at a blow,
To sweep at once her life and beauty too;
But, like a harden'd felon, took a pride
To work more mischievously slow,
And plunder'd first, and then destroy'd.
O double sacrilege on things divine,
To rob the relick, and deface the shrine!
But thus Orinda died:
Heav'n, by the same disease, did both translate;
As equal were their souls, so equal was their fate.

IX.

Meantime her warlike brother on the seas
His waving streamers to the winds displays,
And vows for his return, with vain devotion, pays.
Ah generous youth! that wish forbear,
The winds too soon will waft thee here!
Slack all thy sails, and fear to come,
Alas, thou know'st not, thou art wreck'd at home!
No more shalt thou behold thy sister's face,
Thou hast already had her last embrace.
But look aloft, and if thou kenn'st from far,
Among the Pleiads a new-kindled star,
If any sparkles than the rest more bright,
'Tis she that shines in that propitious light.

X.

When in mid-air the golden trump shall sound,
To raise the nations under ground;
When in the valley of Jehoshaphat,
The judging God shall close the book of fate;
And there the last *assizes* keep
For those who wake and those who sleep:

When

Of Lyric Poetry.

When rattling bones together fly
From the four corners of the ſky;
When ſinews o'er the ſkeletons are ſpread,
Thoſe cloth'd with fleſh, and life inſpires the dead;
The ſacred poets firſt ſhall hear the ſound,
And foremoſt from the tomb ſhall bound,
For they are cover'd with the lighteſt ground;
And ſtraight with in-born vigour, on the wing,
Like mounting larks to the new morning ſing.
There thou, ſweet ſaint, before the quire ſhalt go
As harbinger of heav'n, the way to ſhow,
The way which thou ſo well haſt learnt below.

That this is a fine ode, and not unworthy of the genius of Dryden, muſt be acknowledged; but that it is the nobleſt which the Engliſh language has produced, or that any part of it runs with the torrent of enthuſiaſm which characterizes *Alexander's Feaſt*, are poſitions which we feel not ourſelves inclined to admit. Had the critic by whom it is ſo highly praiſed, inſpected it with the eye which ſcanned the odes of Gray, we cannot help thinking that he would have perceived ſome parts of it to be tediouſly minute in deſcription, and others not very perſpicuous at the firſt peruſal. It may perhaps, upon the whole, rank as high as the following ode by Collins on the Popular Superſtitions of the Highlands of Scotland; but to a higher place it has ſurely no claim.

I.

Home, thou return'ſt from Thames, whoſe Naiads long
Have ſeen thee ling'ring with a fond delay,
Mid thoſe ſoft friends, whoſe hearts ſome future day,
Shall melt, perhaps, to hear thy tragic ſong,
Go, not unmindful of that cordial youth (G)
Whom, long endear'd, thou leav'ſt by Lavant's ſide;
Together let us wiſh him laſting truth,
And joy untainted with his deſtin'd bride.
Go! nor regardleſs, while theſe numbers boaſt
My ſhort-liv'd bliſs, forget my ſocial name;
But think, far off, how, on the ſouthern coaſt,
I met thy friendſhip with an equal flame!
Freſh to that ſoil thou turn'ſt, *where* * ev'ry vale
Shall prompt the poet, and his ſong demand:
To thee thy copious ſubjects ne'er ſhall fail;
Thou need'ſt but take thy pencil to thy hand,
And paint what all believe who own thy genial land.

II.

There muſt thou wake perforce thy Doric quill;
'Tis fancy's land to which thou ſett'ſt thy feet;
Where ſtill, 'tis ſaid, the Fairy people meet,
Beneath each birken ſhade, on mead or hill.
There, each trim laſs, that ſkims the milky ſtore,
To the ſwart tribes their creamy bowl allots;
By night they ſip it round the cottage-door,
While airy minſtrels warble jocund notes.
There, ev'ry herd, by ſad experience, knows,
How, wing'd with Fate, their elf-ſhot arrows fly,
When the ſick ewe her ſummer food foregoes,
Or, ſtretch'd on earth, the heart-ſmit heifers lie.
Such airy beings awe th' untutor'd ſwain:
Nor thou, tho' learn'd, his homelier thoughts neglect:
Let thy ſweet Muſe the rural faith ſuſtain;
Theſe are the themes of ſimple, ſure effect,
That add new conqueſts to her boundleſs reign,
And fill, with double force, her heart-commanding [ſtrain.

III.

Ev'n yet preſerv'd, how often may'ſt thou hear,
Where to the pole the Boreal mountains run,
Taught by the father to his liſt'ning ſon,
Strange lays, whoſe pow'r had charm'd a Spenſer's ear.
At ev'ry pauſe, before thy mind poſſeſt,
Old Runic bards ſhall ſeem to riſe around,
With uncouth lyres in many-colour'd veſt,
Their matted hair with boughs fantaſtic crown'd:
Whether thou bid'ſt the well-taught hind repeat
The choral dirge that mourns ſome chieftain brave,
When ev'ry ſhrieking maid her boſom beat,
And ſtrew'd with choiceſt herbs his ſcented grave;
Or whether ſitting in the ſhepherd's ſhiel (H),
Thou hear'ſt ſome ſounding tale of war's alarms,
When, at the bugle's call, with fire and ſteel,
The ſturdy clans pour'd forth their *brawny* ‡ ſwarms, ‡ bony.
And hoſtile brothers met to prove each other's arms.

IV.

'Tis thine to ſing how framing hideous ſpells, § fits.
In Sky's lone iſle the gifted wizzard-*ſeer* §,
Lodg'd in the wintry cave with Fate's fell ſpear (I),
Or in the depth of Uiſt's dark foreſt dwells:
How they whoſe ſight ſuch dreary dreams engroſs,
With their own viſions oft aſtoniſh'd droop, ‡ embodied.
When, o'er the wat'ry ſtrath, or quaggy moſs,
They ſee the gliding ghoſts *unbodied* ‡ troop. † piercing.
Or, if in ſports, or on the feſtive green,
Their *deſtin'd* † glance ſome fated youth deſcry,
Who now, perhaps, in luſty vigour ſeen,
And roſy health, ſhall ſoon lamented die.
For them the viewleſs forms of air obey;
Their bidding heed, and at their beck repair.
They know what ſpirit brews the ſtormful day,
And heartleſs, oft like moody madneſs, ſtare
To ſee the phantom train their ſecret work prepare.

V.

To monarchs dear (K), ſome hundred miles aſtray,
Oft have they ſeen Fate give the fatal blow!
The ſeer in Sky ſhriek'd as the blood did flow
When headleſs Charles warm on the ſcaffold lay!

(G) A gentleman of the name of *Barrow*, who introduced Home to Collins.

(H) A ſummer hut, built in the high part of the mountains, to tend their flocks in the warm ſeaſon, when the paſture is fine.

(I) Waiting in wintery cave his wayward fits.

(K) Of this beautiful ode two copies have been printed: one by Dr Carlyle, from a manuſcript which he acknowledges to be mutilated; another by an editor who ſeems to hope that a nameleſs ſomebody will be believed, when he declares, that "he diſcovered a *perfect copy* of this admirable ode among ſome old papers in the concealed drawers of a bureau left him by a relation." The preſent age has been already too much amuſed with pretended diſcoveries of poems in the bottoms of *old cheſts*, to pay full credit to an aſſertion of this kind, even though the

Of Lyric Poetry.

As Boreas threw his young Aurora (L) forth,
In the first year of the first George's reign,
And battles rag'd in welkin of the North,
They mourn'd in air, fell, fell rebellion, slain!
And as of late they joy'd in Preston's fight,
Saw at sad Falkirk all their hopes near crown'd!
They rav'd divining through their second-sight (M),
Pale, red Culloden, where these hopes were drown'd!
Illustrious William (N)! Britain's guardian name!
One William sav'd us from a tyrant's stroke;
He, for a sceptre, gain'd heroic fame,
But thou, more glorious, Slavery's chain hast broke,
To reign a private man, and bow to Freedom's yoke!

VI.

These, too, thou'lt sing! for well thy magic muse
Can to the topmost heav'n of grandeur soar!
Or stoop to wail the swain that is no more!
Ah, homely swains! your homeward steps ne'er loose;
Let not dank *Will* (O) mislead you to the heath:
Dancing in mirky night, o'er fen and lake,
He glows, to draw you downward to your death,
In his bewitch'd, low, marshy, willow brake!
What though far off, from some dark dell espied,
His glimm'ring mazes cheer th' excursive sight,
Yet turn, ye wand'rers, turn your steps aside,
Nor trust the guidance of that faithless light;
For watchful, lurking, 'mid th' unrustling reed,
At those mirk hours the wily monster lies,
And listens oft to hear the passing steed,
And frequent round him rolls his sullen eyes,
If chance his savage wrath may some weak wretch surprise.

VII.

Ah, luckless swain, o'er all unblest, indeed!
Whom late bewilder'd in the dank, dark fen,
Far from his flocks, and smoking hamlet, then!
To that sad spot * *where hums the sedgy weed.*

* his way-ward fate shall lead.

On him, enrag'd, the fiend, in angry mood,
Shall never look with pity's kind concern,
But instant, furious, raise the whelming flood
O'er its drown'd banks, forbidding all return!
Or, if he meditate his wish'd escape,
To some dim hill that seems uprising near,
To his faint eye, the grim and grisly shape,
In all its terrors clad, shall wild appear.
Meantime the wat'ry surge shall round him rise,
Pour'd sudden forth from ev'ry swelling source!
What now remains but tears and hopeless sighs?
His fear-shook limbs have lost their youthly force,
And down the waves he floats, a pale and breathless corse!

VIII.

For him in vain his anxious wife shall wait,
Or wander forth to meet him on his way;
For him in vain, at to-fall of the day,
His babes shall linger at th' unclosing gate!
Ah, ne'er shall he return! Alone, if night,
Her travell'd limbs in broken slumbers steep!
With drooping willows drest, his mournful sprite
Shall visit sad, perchance, her silent sleep:
Then he, perhaps, with moist and wat'ry hand,
Shall fondly seem to press her shudd'ring cheek,
And with his blue-swoln face before her stand,
And, shiv'ring cold, these piteous accents speak:
"Pursue, dear wife, thy daily toils pursue,
"At dawn or dusk, industrious as before;
"Nor e'er of me one * *helpless* thought renew,
"While I lie welt'ring on the ozier'd shore,
"Drown'd by the kelpie's † wrath, nor e'er shall aid thee [more!"

* h
† the fiend

IX.

Unbounded is thy range; with varied *skill* *
Thy muse may, like those feath'ry tribes which spring
From their rude rocks, extend her skirting wing
Round the moist marge of each cold Hebrid isle,

* it

To

the scene of discovery be laid in a *bureau*. As the ode of the anonymous editor differs, however, very little from that of Dr Carlyle, and as what is affirmed by a GENTLEMAN *may* be true, though "he chooses not at present to publish his name," we have inserted into our work the copy which pretends to be perfect, noting at the bottom or margin of the page the different readings of Dr Carlyle's edition. In the Doctor's manuscript, which appeared to have been nothing more than the *prima cura*, or first sketch of the poem, the fifth stanza and half of the sixth were wanting; and to give a continued context, he prevailed with Mr M'Kenzie, the ingenious author of the *Man of Feeling*, to fill up the chasm. This he did by the following beautiful lines, which we cannot help thinking much more happy than those which occupy their place in the copy said to be perfect:

"Or on some bellying rock that shades the deep,
They view the lurid signs that cross the sky,
Where in the west the brooding tempests lie;
And hear their first, faint, rustling pennons sweep.
Or in the arched cave, where deep and dark
The broad unbroken billows heave and swell,
In horrid musings wrapt, they sit to mark
The lab'ring moon; or list the nightly yell
Of that dread spirit, whose gigantic form
The seer's entranced eye can well survey,
Through the dim air who guides the driving storm,
And points the wretched bark its destin'd prey.
Or him who hovers on his flagging wing,
O'er the dire whirlpool, that in ocean's waste,
Draws instant down whate'er devoted thing
The falling breeze within its reach hath plac'd—
The distant seaman hears, and flies with trembling haste.

Or if on land the fiend exerts his sway,
Silent he broods o'er quicksand, bog, or fen,
Far from the shelt'ring roof and haunts of men,
When witched darkness shuts the eye of day,
And shrouds each star that wont to cheer the night;
Or if the drifted snow perplex the way,
With treach'rous gleam he lures the fated wight
And leads him flound'ring on and quite astray."

(L) By young Aurora, Collins undoubtedly meant the first appearance of the northern lights, which is commonly said to have happened about the year 1715.

(M) Second-sight is the term that is used for the divination of the Highlanders.

(N) The late duke of Cumberland, who defeated the Pretender at the battle of Culloden.

(O) A fiery meteor, called by various names, such as *Will with the Wisp*, *Jack with the Lanthorn*, &c. It hovers in the air over marshy and fenny places.

To that hoar pile (P) which still its ruin shows:
In whose small vaults a pigmy-folk is found,
Whose bones the delver with his spade upthrows,
And culls them, wond'ring, from the hallow'd ground!
Or thither (Q), where beneath the show'ry west,
The mighty kings of three fair realms are laid:
Once foes, perhaps, together now they rest,
No slaves revere them, and no wars invade:
Yet frequent now, at midnight solemn hour,
The rifted mounds their yawning cells unfold,
And forth the monarchs stalk with sov'reign pow'r
In pageant robes; and, wreath'd with sheeny gold,
And on their twilight tombs aerial council hold.

X.

But, oh! o'er all, forget not Kilda's race,
On whose bleak rocks, which brave the wasting tides,
Fair Nature's daughter, Virtue, yet abides.
Go! just, as they, their blameless manners trace!
Then to my ear transmit some gentle song,
Of those whose lives are yet sincere and plain,
Their bounded walks the rugged cliffs along,
And all their prospect but the wint'ry main.
With sparing temp'rance at the needful time,
They drain the scented spring; or, hunger-prest,
Along th'Atlantic rock, undreading, climb,
And of its eggs despoil the Solan's nest *.
Thus, blest in primal innocence, they live,
Suffic'd, and happy with that frugal fare
Which tasteful toil and hourly danger give.
Hard is their shallow soil, and bleak and bare;
Nor ever vernal bee was heard to murmur there!

XI.

Nor need'st thou blush that such false themes engage
Thy gentle mind, of fairer stores possest;
For not alone they touch the village breast,
But fill'd in elder time th' historic page.
There, Shakespeare's self, with every garland crown'd,
Flew to those fairy climes his fancy sheen (R),
In musing hour; his wayward sisters found,
And with their terrors dress'd the magic scene.
From them he sung, when, 'mid his bold design,
Before the Scot, afflicted, and aghast!
The shadowy kings of Banquo's fated line,
Thro' the dark cave in gleamy pageant pass'd.
Proceed! nor quit the tales which, simply told,
Could once so well my answ'ring bosom pierce;
Proceed, in forceful sounds, and colours bold,
The native legends of thy land rehearse;
To such adapt thy lyre, and suit thy pow'rful verse.

XII.

In scenes like these, which, daring to depart
From sober truth, are still to nature true,
And call forth fresh delight to fancy's view,
Th' heroic muse employ'd her Tasso's art!
How have I trembl'd, when, at Tancred's stroke,
Its gushing blood the gaping cypress pour'd,
When each live plant with mortal accents spoke,
And the wild blast upheav'd the vanish'd sword!
How have I sat, when pip'd the pensive wind,
To hear his harp by British Fairfax strung!
Prevailing poet! whose undoubting mind,
Believ'd the magic wonders which he sung!
Hence, at each sound, imagination glows!
Hence, at each picture, vivid life starts here! (S)
Hence his warm lay with softest sweetness flows!
Melting it flows, pure, *murm'ring**, strong, and clear,
And fills th' impassion'd heart, and wins th' harmonious ear!

XIII.

All hail, ye scenes that o'er my soul prevail!
Ye *splendid*† friths and lakes, which, far away,
Are by smooth Annan‡ fill'd, or past'ral Tay‡,
Or Don's‡ romantic springs, at distance, hail!
The time shall come, when I, perhaps, may tread
Your lowly *glens*§, o'erhung with spreading broom;
Or o'er your stretching heaths, by fancy led,
Or o'er your mountains creep, in awful gloom! (T)
Then will I dress once more the faded bow'r,
Where Jonson (U) sat in Drummond's *classic** shade;
Or crop, from Tiviotdale, each lyric flow'r,
And mourn, on Yarrow's banks, *where Willy's laid*†!
Meantime, ye pow'rs that on the plains which bore
The cordial youth, on Lothian's plains (X), attend!
Where'er *Home dwells*‡, on hill, or lowly moor,
To him I *loose* §, your kind protection lend,
And, touch'd with love like mine, preserve my absent friend!

Of Lyric Poetry.

* Bird-[illegible]

* numerous.

† spacious.

‡ Three rivers in Scotland.

§ valleys.

* social.

† the widowed maid!

‡ he dwells.

§ lose.

Dr Johnson, in his life of Collins, informs us, that Dr Warton and his brother, who had seen this ode in the author's possession, thought it superior to his other works. The taste of the Wartons will hardly be questioned; but we are not sure that the following *Ode to the Passions* has much less merit, though it be merit of a different kind, than the Ode on the Superstitions of the Highlands:

When Music, heav'nly maid, was young,
While yet in early Greece she sung,
The Passions oft, to hear her shell,
Throng'd around her magic cell,
Exulting, trembling, raging, fainting,
Possest beyond the Muse's painting;
By turns they felt the glowing mind
Disturb'd, delighted, rais'd, refin'd:
Till once, 'tis said, when all were fir'd,
Fill'd with fury, rapt, inspir'd,
From the supporting myrtles round
They snatch'd her instruments of sound:
And as they oft had heard apart
Sweet lessons of her forceful art,

Each,

(P) One of the Hebrides is called the *Isle of Pigmies*, where it is reported, that several miniature bones of the human species have been dug up in the ruins of a chapel there.

(Q) Icolmkill, one of the Hebrides, where many of the ancient Scottish, Irish, and Norwegian kings, are said to be interred.

(R) This line wanting in Dr Carlyle's edition.

(S) This line wanting in Dr Carlyle's edition.

(T) This line wanting in Dr Carlyle's edition.

(U) Ben Jonson paid a visit on foot in 1619 to the Scotch poet Drummond, at his seat of Hawthornden, within seven miles of Edinburgh.

(X) Barrow, it seems, was at the university of Edinburgh, which is in the county of Lothian.

Of Lyric Poetry.

Each, for madness rul'd the hour,
Would prove his own expressive power.

First Fear his hand, its skill to try,
Amid the chords bewilder'd laid,
And back recoil'd, he knew not why,
Ev'n at the sound himself had made.

Next Anger rush'd; his eyes on fire,
In lightnings own'd his secret stings;
In one rude clash he struck the lyre,
And swept with hurried hand the strings.

With woeful measures wan Despair—
Low sullen sounds his grief beguil'd;
A solemn, strange, and mingled air;
'Twas sad by fits, by starts 'twas wild.

But thou, O Hope! with eyes so fair,
What was thy delighted measure?
Still it whisper'd promis'd pleasure,
And bade the lovely scenes at distance hail!—
Still would her touch the strain prolong,
And from the rocks, the woods, the vale,
She call'd on Echo still through all her song;
And where her sweetest theme she chose,
A soft responsive voice was heard at every close,
And Hope enchanted smil'd, and wav'd her golden hair.

And longer had she sung;—but, with a frown,
Revenge impatient rose;
He threw his blood-stain'd sword in thunder down,
And, with a withering look,
The war-denouncing trumpet took,
And blew a blast so loud and dread,
Were ne'er prophetic sounds so full of woe.
And ever and anon he beat
The doubling drum with furious heat;
And though sometimes, each dreary pause between,
Dejected Pity at his side
Her soul-subduing voice applied,
Yet still he kept his wild unalter'd mien,
While each strain'd ball of sight seem'd bursting from his head.

Thy numbers, Jealousy, to nought were fix'd,
Sad proof of thy distressful state;
Of differing themes the veering song was mix'd;
And now it courted Love, now raving call'd on Hate.

With eyes up-rais'd, as one inspir'd,
Pale Melancholy sat retir'd,
And from her wild sequester'd seat,
In notes by distance made more sweet,
Pour'd through the mellow horn her pensive soul,
And dashing soft from rocks around,
Bubbling runnels join'd the sound;
Through glades and glooms the mingled measure stole,
Or o'er some haunted streams with fond delay,
Round an holy calm diffusing,
Love of peace, and lonely musing,
In hollow murmurs died away.

But O! how alter'd was its sprightlier tone!
When Cheerfulness, a nymph of healthiest hue,
Her bow across her shoulder flung,
Her buskins gemm'd with morning dew,
Blew an inspiring air, that dale and thicket rung,
The hunter's call to Faun and Dryad known;
The oak-crown'd sisters, and their chaste-ey'd queen,
Satyrs and sylvan boys were seen,
Peeping from forth their alleys green;
Brown Exercise rejoic'd to hear,
And Sport leapt up, and seiz'd his beechen spear.

Last came Joy's ecstatic trial;
He, with viny crown advancing,
First to the lively pipe his hand addrest,
But soon he saw the brisk awakening viol,
Whose sweet entrancing voice he lov'd the best.
They would have thought who heard the strain,
They saw in Tempe's vale her native maids,
Amidst the festal sounding shades,
To some unwearied minstrel dancing,
While, as his flying fingers kiss'd the strings,
Love fram'd with Mirth a gay fantastic round:
Loose were her tresses seen, her zone unbound
And he, amidst his frolic play,
As if he would the charming air repay,
Shook thousand odours from his dewy wings.

O Music! sphere-descended maid,
Friend of pleasure, wisdom's aid,
Why, Goddess, why to us denied?
Lay'st thou thy ancient lyre aside?
As in that lov'd Athenian bower,
You learn'd an all-commanding power:
Thy mimic soul, O Nymph endear'd,
Can well recal what then it heard.
Where is thy native simple heart,
Devote to virtue, fancy, art?
Arise, as in that elder time,
Warm, energic, chaste, sublime!
Thy wonders, in that god-like age,
Fill thy recording sister's page—
'Tis said, and I believe the tale,
Thy humblest reed could more prevail,
Had more of strength, diviner rage,
Than all which charms this laggard age;
Ev'n all at once together found
Cæcilia's mingled world of sound—
O! bid our vain endeavours cease,
Revive the just designs of Greece,
Return in all thy simple state!
Confirm the tales her son's relate.

We shall conclude this section, and these examples, with Gray's *Progress of Poesy*, which, in spite of the severity of Johnson's criticism, certainly ranks high among the odes which pretend to sublimity. The first stanza, when examined by the frigid rules of grammatical criticism, is certainly not faultless; but its faults will be overlooked by every reader who has any portion of the author's fervor:

I. 1.

Awake, Æolian lyre, awake,
And give to rapture all thy trembling strings,
From Helicon's harmonious springs
A thousand rills their mazy progress take:
The laughing flowers, that round them blow,
Drink life and fragrance as they flow.
Now the rich stream of music winds along,
Deep, majestic, smooth, and strong,
Thro' verdant vales, and Ceres' golden reign:
Now rolling down the steep amain,
Headlong, impetuous, see it pour:
The rocks, and nodding groves, rebellow to the roar.

Oh!

yric
ry.

I. 2.

Oh! Sovereign of the willing ſoul,
Parent of ſweet and ſolemn-breathing airs,
Enchanting ſhell! the ſullen cares,
And frantic paſſions, hear thy ſoft controul.
On Thracia's hills the lord of war
Has curb'd the fury of his car,
And dropp'd his thirſty lance at thy command.
Perching on the ſceptred hand
Of Jove, thy magic lulls the feather'd king
With ruffled plumes, and flagging wing:
Quench'd in dark clouds of ſlumber lie
The terror of his beak, and lightnings of his eye.

I. 3.

Thee the voice, the dance, obey,
Temper'd to thy warbled lay:
O'er Idalia's velvet-green
The roſy-crowned loves are ſeen.
On Cytherea's day,
With antic ſports, and blue-ey'd pleaſures,
Friſking light in frolic meaſures;
Now purſuing, now retreating,
Now in circling troops they meet;
To briſk notes, in cadence beating,
Glance their many-twinkling feet.
Slow melting ſtrains their queen's approach declare:
Where'er ſhe turns, the graces homage pay.
With arms ſublime, that float upon the air,
In gliding ſtate ſhe wins her eaſy way:
O'er her warm cheek, and riſing boſom, move
The bloom of young deſire, and purple light of love.

II. 1.

Man's feeble race what ills await;
Labour, and penury, the racks of pain,
Diſeaſe, and ſorrow's weeping train,
And death, ſad refuge from the ſtorms of fate!
The fond complaint, my ſong, diſprove,
And juſtify the laws of Jove.
Say, has he giv'n in vain the heav'nly muſe?
Night, and all her ſickly dews,
Her ſpectres wan, and birds of boding cry,
He gives to range the dreary ſky;
Till down the eaſtern cliffs afar
Hyperion's march they ſpy, and glitt'ring ſhafts of war.

II. 2.

In climes beyond the ſolar road,
Where ſhaggy forms o'er ice-built mountains roam,
The Muſe has broke the twilight-gloom,
To cheer the ſhiv'ring native's dull abode.
And oft, beneath the od'rous ſhade
Of Chili's boundleſs foreſts laid,
She deigns to hear the ſavage youth repeat,
In looſe numbers wildly ſweet,
Their feather-cinctur'd chiefs, and duſky loves.
Her tract, where'er the goddeſs roves,
Glory purſue, and gen'rous ſhame,
Th' unconquerable mind, and freedom's holy flame.

II. 3.

Woods, that wave o'er Delphi's ſteep,
Iſles, that crown th' Ægean deep,
Fields, that cool Iliſſus laves,
Or where Mæander's amber waves
In ling'ring lab'rinths creep,
How do your tuneful echoes languiſh
Mute, but to the voice of anguiſh!
Where each old poetic mountain
Inſpiration breath'd around;
Ev'ry ſhade and hallow'd fountain
Murmur'd deep a ſolemn ſound:
Till the ſad nine, in Greece's evil hour,
Left their Parnaſſus for the Latian plains.
Alike they ſcorn the pomp of tyrant power,
And coward vice that revels in her chains.
When Latium had her lofty ſpirit loſt,
They ſought, oh Albion! next thy ſea-encircled coaſt.

Of Lyric Poetry.

III. 1.

Far from the ſun, and ſummer-gale,
In thy green lap was nature's* darling laid,
What time, where lucid Avon ſtray'd,
To him the mighty mother did unveil
Her awful face: the dauntleſs child
Stretch'd forth his little arms, and ſmil'd.
This pencil take (ſhe ſaid) whoſe colours clear
Richly paint the vernal year:
Thine too theſe golden keys, immortal boy!
This can unlock the gates of joy;
Of horror that, and thrilling fears,
Or ope the ſacred ſource of ſympathetic tears.

* Shakeſpear.

III. 2.

Nor ſecond he †, that rode ſublime
Upon the ſeraph-wings of ecſtaſy,
The ſecrets of th' abyſs to ſpy.
He paſs'd the flaming bounds of place and time:
The living throne, the ſapphire blaze,
Where angels tremble while they gaze,
He ſaw; but, blaſted with exceſs of light,
Clos'd his eyes in endleſs night.
Behold, where Dryden's leſs preſumptuous car,
Wide o'er the fields of glory bear
Two courſers of ethereal race,
With necks in thunder cloth'd, and long-reſounding [pace.

† Milton.

III. 3.

Hark, his hands the lyre explore!
Bright-ey'd fancy, hov'ring o'er,
Scatters from her pictur'd urn
Thoughts, that breathe, and words, that burn.
But ah! 'tis heard no more—
Oh! Lyre divine, what daring ſpirit
Wakes thee now? tho' he inherit
Nor the pride, nor ample pinion,
That the Theban eagle bear,
Sailing with ſupreme dominion
Through the azure deep of air:
Yet oft before his infant eyes would run
Such forms as glitter in the Muſe's ray,
With orient hues, unborrow'd of the ſun:
Yet ſhall he mount, and keep his diſtant way
Beyond the limits of a vulgar fate,
Beneath the good how far—but far above the great.

Sect. III. *Of the Elegy.*

133
The elegy;

The *Elegy* is a *mournful* and *plaintive*, but yet ſweet and engaging, kind of poem. It was firſt invented to bewail the death of a friend; and afterwards uſed to expreſs the complaints of lovers, or any other melancholy ſubject. In proceſs of time, not only matters of grief, but joy, wiſhes, prayers, expoſtulations, reproaches, admonitions, and almoſt every other ſubject, were admitted into elegy; however, funeral lamentations and affairs of love

4.

Elegy.

love seem most agreeable to its character, which is gentleness and tenuity.

The plaintive elegy, in mournful state,
Dishevell'd weeps the stern decrees of fate;
Now paints the lover's torments and delights;
Now the nymph flatters, threatens, or invites.
But he, who would these passions well express,
Must more of love than poetry possess.
I hate those lifeless writers whose forc'd fire
In a cold style describes a hot desire;
Who sigh by rule, and, raging in cold blood,
Their sluggish muse spur to an am'rous mood.
Their ecstasies insipidly they feign;
And always pine, and fondly hug their chain;
Adore their prison, and their suff'rings bless;
Make sense and reason quarrel as they please.
'Twas not of old in this affected tone,
That smooth Tibullus made his am'rous moan;
Or tender Ovid, in melodious strains,
Of love's dear art the pleasing rules explains.
You, who in elegy would justly write,
Consult your heart; let that alone endite.
[*From the French of* Despreux.] SOAMES.

134 How to be made.

The plan of an elegy, as indeed of all other poems, ought to be made before a line is written; or else the author will ramble in the dark, and his verses have no dependance on each other. No *epigrammatic points* or conceits, none of those *fine things* which most people are so fond of in every sort of poem, can be allowed in this, but must give place to nobler beauties, those of *nature* and the *passions*. Elegy rejects whatever is facetious, satirical, or majestic, and is content to be plain, decent, and unaffected; yet in this humble state is she sweet and engaging, elegant and attractive. This poem is adorned with frequent *commiserations*, *complaints*, *exclamations*, *addresses to things or persons*, short and proper *digressions*, *allusions*, *comparisons*, *prosopopœias* or feigned persons, and sometimes with short *descriptions*. The diction ought to be free from any *harshness*; *neat*, *easy*, *perspicuous*, *expressive of the manners*, *tender*, and *pathetic*; and the numbers should be *smooth* and *flowing*, and captivate the ear with their uniform sweetness and delicacy.

Of elegies on the subject of death, that by Mr Gray, written in a country church-yard, is one of the best that has appeared in our language, and may be justly esteemed a masterpiece. But being so generally known, it would be superfluous to insert it here.

On the subject of love, we shall give an example from the elegies of Mr Hammond.

Let others boast their heaps of shining gold,
  And view their fields with waving plenty crown'd,
Whom neigh'ring foes in constant terror hold,
  And trumpets break their slumbers, never sound:
While, calmly poor, I trifle life away,
  Enjoy sweet leisure by my cheerful fire,
No wanton hope my quiet shall betray,
  But cheaply bless'd I'll scorn each vain desire.
With timely care I'll sow my little field,
  And plant my orchard with its master's hand;
Nor blush to spread the hay, the hook to wield,
  Or range my sheaves along the sunny land.
If late at dusk, while carelesly I roam,
  I meet a strolling kid or bleating lamb,
Under my arm I'll bring the wand'rer home,
  And not a little chide its thoughtless dam.
What joy to hear the tempest howl in vain,
  And clasp a fearful mistress to my breast?
Or lull'd to slumber by the beating rain,
  Secure and happy sink at last to rest.
Or if the sun in flaming Leo ride,
  By shady rivers indolently stray,
And, with my DELIA walking side by side,
  Hear how they murmur, as they glide away.
What joy to wind along the cool retreat,
  To stop and gaze on DELIA as I go!
To mingle sweet discourse with kisses sweet,
  And teach my lovely scholar all I know!
Thus pleas'd at heart, and not with fancy's dream,
  In silent happiness I rest unknown;
Content with what I am, not what I seem,
  I live for DELIA and myself alone.
Ah foolish man! who, thus of her possess'd,
  Could float and wander with ambition's wind,
And, if his outward trappings spoke him blest,
  Not heed the sickness of his conscious mind.
With her I scorn the idle breath of praise,
  Nor trust to happiness that's not our own;
The smile of fortune might suspicion raise,
  But here I know that I am lov'd alone.
STANHOPE, in wisdom as in wit divine,
  May rise and plead Britannia's glorious cause,
With steady rein his eager wit confine,
  While manly sense the deep attention draws.
Let STANHOPE speak his list'ning country's wrong,
  My humble voice shall please one partial maid;
For her alone I pen my tender song,
  Securely sitting in his friendly shade.
STANHOPE shall come, and grace his rural friend;
  DELIA shall wonder at her noble guest,
With blushing awe the riper fruit commend,
  And for her husband's patron cull the best.
Hers be the care of all my little train,
  While I with tender indolence am blest,
The favourite subject of her gentle reign,
  By love alone distinguish'd from the rest.
For her I'll yoke my oxen to the plough,
  In gloomy forests tend my lonely flock,
For her a goat-herd climb the mountain's brow,
  And sleep extended on the naked rock.
Ah! what avails to press the stately bed,
  And far from her 'midst tasteless grandeur weep,
By marble fountains lay the pensive head,
  And, while they murmur, strive in vain to sleep!
DELIA alone can please and never tire,
  Exceed the paint of thought in true delight;
With her, enjoyment wakens new desire,
  And equal rapture glows thro' ev'ry night.
Beauty and worth in her alike contend
  To charm the fancy, and to fix the mind;
In her, my wife, my mistress, and my friend,
  I taste the joys of sense and reason join'd.
On her I'll gaze when others loves are o'er,
  And dying press her with my clay-cold hand——
Thou weep'st already, as I were no more,
  Nor can that gentle breast the thought withstand.
Oh! when I die, my latest moments spare,
  Nor let thy grief with sharper torments kill:
Wound not thy cheeks, nor hurt that flowing hair;
  Tho' I am dead, my soul shall love thee still.

Oh

Oh quit the room, oh quit the deathful bed,
  Or thou wilt die, ſo tender is thy heart!
Oh leave me, DELIA! ere thou ſee me dead,
  Theſe weeping friends will do thy mournful part.
Let them, extended on the decent bier,
  Convey the corſe in melancholy ſtate,
Thro' all the village ſpread the tender tear,
  While pitying maids our wond'rous love relate.

SECT. IV. *Of the Paſtoral.*

THIS poem takes its name from the Latin word *paſtor*, a "ſhepherd;" the ſubject of it being ſomething in the paſtoral or rural life; and the perſons, interlocutors, introduced in it, either ſhepherds or other ruſtics.

135 Paſtorals. These poems are frequently called *eclogues*, which ſignifies "ſelect or choice pieces;" though ſome account for this name in a different manner. They are alſo called *bucolicks*, from Βουκολος, "a herdſman."

136 Its general character. This kind of poem, when happily executed, gives great delight; nor is it a wonder, ſince innocence and ſimplicity generally pleaſe: to which let us add, that the ſcenes of paſtorals are uſually laid in the country, where both poet and painter have abundant matter for the exerciſe of genius, ſuch as enchanting proſpects, purling ſtreams, ſhady groves, enamelled meads, flowery lawns, rural amuſements, the bleating of flocks, and the muſic of birds; which is of all melody the moſt ſweet and pleaſing, and calls to our mind the wiſdom and taſte of Alexander, who, on being importuned to hear a man that imitated the notes of the nightingale, and was thought a great curioſity, replied, that *he had had the happineſs of hearing the nightingale herſelf.*

137 Character. The character of the paſtoral conſiſts in ſimplicity, brevity, and delicacy; the two firſt render an eclogue *natural*, and the laſt *delightful*. With reſpect to nature, indeed, we are to conſider, that as a paſtoral is an image of the ancient times of innocence and undeſigning plainneſs, we are not to deſcribe ſhepherds as they really are at this day, but as they may be conceived then to have been, when the beſt of men, and even princes, followed the employment. For this reaſon, an air of piety ſhould run through the whole poem; which is viſible in the writings of antiquity.

To make it natural with reſpect to the preſent age, ſome knowledge in rural affairs ſhould be diſcovered, and that in ſuch a manner as if it was done by chance rather than by deſign; leſt by too much pains to ſeem natural, that ſimplicity be deſtroyed from whence ariſes the delight; for what is ſo engaging in this kind of poeſy proceeds not ſo much from the idea of a country life itſelf, as in expoſing only the beſt part of a ſhepherd's life, and concealing the misfortunes and miſeries which ſometimes attend it. Beſides, the ſubject muſt contain ſome particular beauty in itſelf, and each eclogue preſent a ſcene or proſpect to our view enriched with variety: which variety is in a great meaſure obtained by frequent compariſons drawn from the moſt agreeable objects of the country; by interrogations to things inanimate; by ſhort and beautiful digreſſions; and by elegant turns on the words, which render the numbers more ſweet and pleaſing. To this let us add, that the connections muſt be negligent, the narrations and deſcriptions ſhort, and the periods conciſe.

Riddles, parables, proverbs, antique phraſes, and ſuperſtitious fables, are fit materials to be intermixed with this kind of poem. They are here, when properly applied, very ornamental; and the more ſo, as they give our modern compoſitions the air of the ancient manner of writing.

The ſtyle of the paſtoral ought to be humble, yet pure; neat, but not florid; eaſy, and yet lively: and the numbers ſhould be ſmooth and flowing. 138 Style.

This poem in general ſhould be ſhort, and ought never much to exceed 100 lines; for we are to conſider that the ancients made theſe ſort of compoſitions their amuſement, and not their buſineſs: but however ſhort they are, every eclogue muſt contain a plot or fable, which muſt be ſimple and one; but yet ſo managed as to admit of ſhort digreſſions. Virgil has always obſerved this.——We ſhall give the plot or argument of his firſt paſtoral as an example. Melibœus, *an unfortunate ſhepherd, is introduced with* Tityrus, *one in more fortunate circumſtances; the former addreſſes the complaint of his ſufferings and baniſhment to the latter, who enjoys his flocks and folds in the midſt of the public calamity, and therefore expreſſes his gratitude to the benefactor from whom this favour flowed: but* Melibœus *accuſes fortune, civil wars, and bids adieu to his native country.* This is therefore a dialogue.

But we are to obſerve, that the poet is not always obliged to make his eclogue *allegorical*, and to have real perſons repreſented by the fictitious characters introduced; but is in this reſpect entirely at his own liberty.

Nor does the nature of the poem require it to be always carried on by way of dialogue; for a ſhepherd may with propriety ſing the praiſes of his love, complain of her inconſtancy, lament her abſence, her death, &c. and addreſs himſelf to groves, hills, rivers, and ſuch like rural objects, even when alone.

We ſhall now give an example from each of thoſe authors who have eminently diſtinguiſhed themſelves by this manner of writing, and introduce them in the order of time in which they were written.

Theocritus, who was the father or inventor of this kind of poetry, has been deſervedly eſteemed by the beſt critics; and by ſome, whoſe judgment we cannot diſpute, preferred to all other paſtoral writers, with perhaps the ſingle exception of the tender and delicate Geſner. We ſhall inſert his third *idyllium*, not becauſe it is the beſt, but becauſe it is within our compaſs. 139 Examples of the paſtoral from Theocritus.

To Amaryllis, lovely nymph, I ſpeed,
Meanwhile my goats upon the mountains feed.
O Tityrus, tend them with aſſiduous care,
Lead them to cryſtal ſprings and paſtures fair,
And of the ridgling's butting horns beware.
Sweet Amaryllis, have you then forgot
Our ſecret pleaſures in the conſcious grott,
Where in my folding arms you lay reclin'd?
Bleſt was the ſhepherd, for the nymph was kind.
I whom you call'd *your Dear, your Love*, ſo late,
Say, am I now the object of your hate?
Say, is my form diſpleaſing to your ſight?
This cruel love will ſurely kill me quite.
Lo! ten large apples, tempting to the view,
Pluck'd from your favourite tree, where late they grew.
Accept this boon, 'tis all my preſent ſtore;
To-morrow will produce as many more.

Pastoral.

Meanwhile these heart-consuming pains remove,
And give me gentle pity for my love.
Oh! was I made by some transforming power
A bee to buzz in your sequester'd bow'r!
To pierce your ivy shade with murmuring sound,
And the light leaves that compass you around.
I know thee, Love, and to my sorrow find,
A god thou art, but of the savage kind;
A lioness sure suckled the fell child,
And with his brothers nurst him in the wild;
On me his scorching flames incessant prey,
Glow in my bones, and melt my soul away.
Ah, nymph, whose eyes destructive glances dart,
Fair is your face, but flinty is your heart:
With kisses kind this rage of love appease;
For me, fond swain! ev'n empty kisses please.
Your scorn distracts me, and will make me tear
The flow'ry crown I wove for you to wear,
Where roses mingle with the ivy-wreath,
And fragrant herbs ambrosial odours breathe.
Ah me! what pangs I feel; and yet the fair
Nor sees my sorrows nor will hear my pray'r.
I'll doff my garments, since I needs must die,
And from yon rock that points its summit high,
Where patient Alpis snares the finny fry,
I'll leap, and, though perchance I rise again,
You'll laugh to see me plunging in the main.
By a prophetic poppy-leaf I found
Your chang'd affection, for it gave no sound,
Though in my hand struck hollow as it lay,
But quickly wither'd like your love away.
An old witch brought sad tidings to my ears,
She who tells fortunes with the sieve and sheers
For leasing barley in my fields of late,
She told me, I should love, and you should hate!
For you my care a milk-white goat supply'd,
Two wanton kids run frisking at her side;
Which oft the nut-brown maid, Erithacis,
Has begg'd and paid before-hand with a kiss;
And since you thus my ardent passion slight,
Her's they shall be before to-morrow night.
My right eye itches; may it lucky prove,
Perhaps I soon shall see the nymph I love;
Beneath yon pine I'll sing distinct and clear,
Perhaps the fair my tender notes shall hear;
Perhaps may pity my melodious moan;
She is not metamorphos'd into stone.
Hippomenes, provok'd by noble strife,
To win a mistress, or to lose his life,
Threw golden fruit in Atalanta's way:
The bright temptation caus'd the nymph to stay;
She look'd, she languish'd, all her soul took fire,
She plung'd into the gulph of deep desire.
To Pyle from Othrys sage Melampus came,
He drove the lowing herd, yet won the dame;
Fair Pero blest his brother Bias' arms,
And in a virtuous race diffus'd unfading charms.
Adonis fed his cattle on the plain,
And sea-born Venus lov'd the rural swain;
She mourn'd him wounded in the fatal chace,
Nor dead dismiss'd him from her warm embrace.
Though young Endymion was by Cynthia blest,
I envy nothing but his lasting rest.
Jasion slumb'ring on the Cretan plain
Ceres once saw, and blest the happy swain
With pleasures too divine for ears profane.
My head grows giddy, love affects me sore;
Yet you regard not; so I'll sing no more——
Here will I put a period to my care—
Adieu, false nymph, adieu ungrateful fair;
Stretch'd near the grotto, when I've breath'd my last,
My corse will give the wolves a rich repast,
As sweet to them as honey to your taste.

FAWKES.

Virgil succeeds Theocritus, from whom he has in some places copied, and always imitated with success. As a specimen of his manner, we shall introduce his first pastoral, which is generally allowed to be the most perfect.

MELIBOEUS and TITYRUS.

Mel. Beneath the shade which beechen boughs diffuse,
You, Tityrus, entertain your sylvan muse.
Round the wide world in banishment we roam,
Forc'd from our pleasing fields and native home;
While stretch'd at ease you sing your happy loves,
And Amyrillis fills the shady groves.
Tit. These blessings, friend, a deity bestow'd;
For never can I deem him less than god.
The tender firstlings of my woolly breed
Shall on his holy altar often bleed.
He gave me kine to graze the flow'ry plain,
And so my pipe renew'd the rural strain.
Mel. I envy not your fortune; but admire,
That while the raging sword and wasteful fire
Destroy the wretched neighbourhood around,
No hostile arms approach your happy ground.
Far diff'rent is my fate; my feeble goats
With pains I drive from their forsaken cotes:
And this you see I scarcely drag along,
Who yeaning on the rocks has left her young,
The hope and promise of my falling fold,
My loss by dire portents the gods foretold;
For, had I not been blind, I might have seen
Yon riven oak, the fairest on the green,
And the hoarse raven on the blasted bough
By croaking from the left presag'd the coming blow.
But tell me, Tityrus, what heav'nly pow'r
Preserv'd your fortunes in that fatal hour?
Tit. Fool that I was, I thought imperial Rome
Like Mantua, where on market-days we come,
And thither drive our tender lambs from home.
So kids and whelps their sires and dams express;
And so the great I measur'd by the less:
But country-towns, compar'd with her, appear
Like shrubs when lofty cypresses are near.
Mel. What great occasion call'd you hence to Rome?
Tit. Freedom, which came at length, tho' slow to come:
Nor did my search of liberty begin
Till my black hairs were chang'd upon my chin;
Nor Amaryllis would vouchsafe a look,
Till Galatea's meaner bonds I broke.
Till then a helpless, hopeless, homely swain,
I sought not freedom, nor aspir'd to gain:
Tho' many a victim from my folds was bought,
And many a cheese to country markets brought,
Yet all the little that I got I spent,
And still return'd as empty as I went.
Mel. We stood amaz'd to see your mistress mourn,
Unknowing that she pin'd for your return;
We wonder'd why she kept her fruit so long,
For whom so late th' ungather'd apples hung:

But

ral. Pastoral.

But now the wonder ceases, since I see
She kept them only, Tityrus, for thee:
For thee the bubbling springs appear'd to mourn,
And whisp'ring pines made vows for thy return.
Tit. What should I do? while here I was enchain'd,
No glimpse of godlike liberty remain'd;
Nor could I hope in any place but there
To find a god so present to my pray'r.
There first the youth of heav'nly birth I view'd,
For whom our monthly victims are renew'd.
He heard my vows, and graciously decreed
My grounds to be restor'd my former flocks to feed.
Mel. O fortunate old man! whose farm remains
For you sufficient, and requites your pains,
Though rushes overspread the neighb'ring plains,
Tho' here the marshy grounds approach your fields,
And there the soil a stony harvest yields.
Your teeming ewes shall no strange meadows try,
Nor fear a rot from tainted company.
Behold yon bord'ring fence of sallow trees
Is fraught with flow'rs, the flow'rs are fraught with [bees:
The busy bees, with a soft murm'ring strain,
Invite to gentle sleep the lab'ring swain:
While from the neighb'ring rock with rural songs
The pruner's voice the pleasing dream prolongs;
Stock-doves and turtles tell their am'rous pain,
And, from the lofty elms, of love complain.
Tit. Th' inhabitants of seas and skies shall change,
And fish on shore and stags in air shall range,
The banish'd Parthian dwell on Arar's brink,
And the blue German shall the Tigris drink;
Ere I, forsaking gratitude and truth,
Forget the figure of that godlike youth.
Mel. But we must beg our bread in climes unknown,
Beneath the scorching or the freezing zone;
And some to fair Oaxis shall be sold,
Or try the Libyan heat or Scythian cold;
The rest among the Britons be confin'd,
A race of men from all the world disjoin'd.
O! must the wretched exiles ever mourn?
Nor after length of rolling years return?
Are we condemn'd by Fate's unjust decree,
No more our houses and our homes to see?
Or shall we mount again the rural throne,
And rule the country, kingdoms once our own?
Did we for these barbarians plant and sow,
On these, on these, our happy fields bestow?
Good heav'n, what dire effects from civil discord flow!
Now let me graft my pears, and prune the vine;
The fruit is theirs, the labour only mine.
Farewel my pastures, my paternal stock!
My fruitful fields, and my more fruitful flock!
No more, my goats, shall I behold you climb
The steepy cliffs, or crop the flow'ry thyme;
No more extended in the grot below,
Shall see you browzing on the mountain's brow
The prickly shrubs, and after on the bare
Lean down the deep abyss and hang in air!
No more my sheep shall sip the morning dew;
No more my song shall please the rural crew:
Adieu, my tuneful pipe! and all the world, adieu!
Tit. This night, at least, with me forget your care;
Chesnuts and curds and cream shall be your fare:
The carpet-ground shall be with leaves o'er-spread,
And boughs shall weave a cov'ring for your head:
For see yon sunny hill the shade extends,
And curling smoke from cottages ascends.

DRYDEN.

Spenser was the first of our countrymen who acquired any considerable reputation by this method of writing. We shall insert his sixth eclogue, or that for June, which is allegorical, as will be seen by the

ARGUMENT. " Hobbinol, from a description of the pleasures of the place, excites Colin to the enjoyment of them. Colin declares himself incapable of delight, by reason of his ill success in love, and his loss of Rosalind, who had treacherously forsaken him for Menalcas another shepherd. By Tityrus (mentioned before in Spenser's second eclogue, and again in the twelfth) is plainly meant Chaucer, whom the author sometimes professed to imitate. In the person of Colin is represented the author himself; and Hobbinol's inviting him to leave the hill country, seems to allude to his leaving the North, where, as is mentioned in his life, he had for some time resided."

Hob. Lo! Colin, here the place, whose pleasant sight
From other shades hath wean'd my wand'ring mind:
Tell me, what wants me here, to work delight?
The simple air, the gentle warbling wind,
So calm, so cool, as nowhere else I find:
The grassy ground with dainty daisies dight,
The bramble-bush, where birds of every kind
To th' water's fall their tunes attemper right.
Col. O! happy Hobbinol, I bless thy state,
That paradise hast found which Adam lost.
Here wander may thy flock early or late,
Withouten dread of wolves to been ytost;
Thy lovely lays here mayst thou freely boast:
But I, unhappy man! whom cruel fate,
And angry gods, pursue from coast to coast,
Can nowhere find to shroud my luckless pate.
Hob. Then if by me thou list advised be,
Forsake the soil that so doth thee bewitch:
Leave me those hills, where harbroughnis to see,
Nor holly-bush, nor brere, nor winding ditch;
And to the dales resort, where shepherds rich,
And fruitful flocks been everywhere to see:
Here no night-ravens lodge, more black than pitch,
Nor elvish ghosts, nor ghastly owls do flee.
But friendly fairies met with many graces,
And light-foot nymphs can chace the ling'ring night,
With heydeguies, and trimly trodden traces;
Whilst sisters nine, which dwell on Parnass' height,
Do make them music, for their more delight;
And Pan himself to kiss their crystal faces,
Will pipe and dance, when Phœbe shineth bright:
Such peerless pleasures have we in these places.
Col. And I whilst youth, and course of careless years,
Did let me walk withouten links of love,
In such delights did joy amongst my peers:
But riper age such pleasures doth reprove,
My fancy eke from former follies move
To strayed steps: for time in passing wears
(As garments doen, which waxen old above)
And draweth new delights with hoary hairs.
Though couth I sing of love, and tune my pipe
Unto my plantive pleas in verses made:
Though would I seek for queen-apples unripe
To give my Rosalind, and in sommer shade

Paftoral.

Dight gawdy girlonds was my common trade,
To crown her golden locks: but years more ripe,
And lofs of her, whofe love as life I wayde,
Thofe weary wanton toys away did wipe.
Hob. Colin, to hear thy rhymes and roundelays,
Which thou wert wont on wafteful hills to fing,
I more delight, than lark in fommer days:
Whofe echo made the neighbour groves to ring,
And taught the birds, which in the lower fpring
Did fhroud in fhady leaves from funny rays,
Frame to thy fong their cheerful cheriping,
Or hold their peace, for fhame of thy fweet lays.
I faw Calliope with mufes moe,
Soon as thy oaten pipe began to found,
Their ivory lutes and tamburins forego,
And from the fountain, where they fate around,
Ren after haftily thy filver found.
But when they came, where thou thy fkill didft fhow,
They drew aback, as half with fhame confound,
Shepherd to fee, them in their art out-go.
Col. Of mufes, Hobbinol, I con no fkill,
For they been daughters of the higheft Jove,
And holden fcorn of homely fhepherds quill:
For fith I heard that Pan with Phœbus ftrove
Which him to much rebuke and danger drove,
I never lift prefume to Parnafs' hill,
But piping low, in fhade of lowly grove,
I play to pleafe myfelf, albeit ill.
Nought weigh I, who my fong doth praife or blame,
Ne ftrive to win renown, or pafs the reft:
With fhepherds fits not follow flying fame,
But feed his flocks in fields, where falls him beft.
I wot my rimes been rough, and rudely dreft;
The fitter they, my careful cafe to frame:
Enough is me to paint out my unreft,
And pour my piteous plaints out in the fame.
The God of fhepherds, Tityrus, is dead,
Who taught me homely, as I can, to make:
He, whilft he liv'd, was the fovereign head
Of fhepherds all, that been with love ytake.
Well couth he wail his woes, and lightly flake
The flames which love within his heart had bred,
And tell us merry tales to keep us wake,
The while our fheep about us fafely fed.
Now dead he is, and lieth wrapt in lead,
(O why fhould death on him fuch outrage fhow!)
And all his paffing fkill with him is fled,
The fame whereof doth daily greater grow.
But if on me fome little drops would flow
Of that the fpring was in his learned hed,
I foon would learn thefe woods to wail my woe,
And teach the trees their trickling tears to fhed.
Then fhould my plaints, caus'd of difcourtefee,
As meffengers of this my painful flight,
Fly to my love, wherever that fhe be,
And pierce her heart with point of worthy wight;
As fhe deferves, that wrought fo deadly fpight.
And thou, Menalcas, that by treachery
Didft underfong my lafs to wax fo light,
Should'ft well be known for fuch thy villany.
But fince I am not, as I wifh I were,
Ye gentle fhepherds, which your flocks do feed,
Whether on hills or dales, or other where,
Bear witnefs all of this fo wicked deed:
And tell the lafs, whofe flower is woxe a weed,
And faultlefs faith is turn'd to faithlefs feere,
That fhe the trueft fhepherd's heart made bleed,
That lives on earth, and loved her moft dear.
Hob. O! careful Colin, I lament thy cafe,
Thy tears would make the hardeft flint to flow!
Ah! faithlefs Rofalind, and void of grace,
That art the root of all this rueful woe!
But now is time, I guefs, homeward to go;
Then rife, ye bleffed flocks, and home apace,
Left night with ftealing fteps do you foreflo,
And wet your tender lambs that by you trace.

By the following eclogue the reader will perceive that Mr Philips has, in imitation of Spenfer, preferved in his paftorals many antiquated words, which, though they are difcarded from polite converfation, may naturally be fuppofed ftill to have place among the fhepherds and other ruftics in the country. We have made choice of his fecond eclogue, becaufe it is brought home to his own bufinefs, and contains a complaint againft thofe who had fpoken ill of him and his writings.

THENOT, COLINET.

Th. Is it not Colinet I lonefome fee
Leaning with folded arms againft the tree?
Or is it age of late bedims my fight?
'Tis Colinet, indeed, in woful plight.
Thy cloudy look, why melting into tears,
Unfeemly, now the fky fo bright appears?
Why in this mournful manner art thou found,
Unthankful lad, when all things fmile around?
Or hear'ft not lark and linnet jointly fing,
Their notes blithe-warbling to falute the fpring?
Co. Tho' blithe their notes, not fo my wayward fate;
Nor lark would fing, nor linnet, in my ftate.
Each creature, Thenot, to his tafk is born;
As they to mirth and mufic, I to mourn.
Waking, at midnight, I my woes renew,
My tears oft mingling with the falling dew.
Th. Small caufe, I ween, has lufty youth to plain;
Or who may then the weight of eld fuftain,
When every flackening nerve begins to fail,
And the load preffeth as our days prevail?
Yet though with years my body downward tend,
As trees beneath their fruit in autumn bend,
Spite of my fnowy head and icy veins,
My mind a cheerful temper ftill retains:
And why fhould man, mifhap what will, repine,
Sour every fweet, and mix with tears his wine?
But tell me then; it may relieve thy woe,
To let a friend thine inward ailment know.
Co. Idly 'twill wafte thee, Thenot, the whole day,
Should'ft thou give ear to all my grief can fay.
Thine ewes will wander; and the heedlefs lambs,
In loud complaints, require their abfent dams.
Th. See Lightfoot; he fhall tend them clofe: and I,
'Tween whiles, acrofs the plain will glance mine eye.
Co. Where to begin I know not, where to end.
Does there one fmiling hour my youth attend?
Though few my days, as well my follies fhow,
Yet are thofe days all clouded o'er with wo:
No happy gleam of funfhine doth appear,
My low'ring fky and wint'ry months to cheer.
My piteous plight in yonder naked tree,
Which bears the thunder-fcar too plain, I fee:
Quite deftitute it ftands of fhelter kind,
The mark of ftorms, and fport of every wind:

The

ral. The riven trunk feels not the approach of fpring ;
Nor birds among the leaflefs branches fing :
No more, beneath thy fhade, fhall fhepherds throng
With jocund tale, or pipe, or pleafing fong.
Ill-fated tree! and more ill-fated I!
From thee, from me, alike the fhepherds fly.
Th. Sure thou in haplefs hour of time waft born,
When blightning mildews fpoil the rifing corn,
Or blafting winds o'er bloffom'd hedge-rows pafs,
To kill the promis'd fruits, and fcorch the grafs ;
Or when the moon, by wizard charm'd, forefhows,
Blood-ftain'd in foul eclipfe, impending woes.
Untimely born, ill luck betides thee ftill.
Co. And can there, Thenot, be a greater ill?
Th. Nor fox, nor wolf, nor rot among our fheep:
From thefe good fhepherd's care his flock may keep:
Againft ill luck, alas! all forecaft fails;
Nor toil by day, nor watch by night, avails.
Co. Ah me, the while! ah me, the lucklefs day!
Ah lucklefs lad! befits me more to fay.
Unhappy hour! when frefh in youthful bud,
I left, Sabrina fair, thy filv'ry flood.
Ah filly I! more filly than my fheep,
Which on thy flow'ry banks I wont to keep.
Sweet are thy banks; oh, when fhall I once more
With ravifh'd eyes review thine amell'd fhore?
When, in the cryftal of thy waters, fcan
Each feature faded, and my colour wan?
When fhall I fee my hut, the fmall abode
Myfelf did raife and cover o'er with fod?
Small though it be, a mean and humble cell,
Yet is there room for peace and me to dwell.
Th. And what enticement charm'd thee far away
From thy lov'd home, and led thy heart aftray?
Co. A lewd defire ftrange lands and fwains to know.
Ah me! that ever I fhould covet wo.
With wand'ring feet unbleft, and fond of fame,
I fought I know not what befides a name.
Th. Or, footh to fay, didft thou not hither rome
In fearch of gains more plenty than at home?
A rolling ftone is ever bare of mofs;
And, to their coft, green years old proverbs crofs.
Co. Small need there was, in random fearch of gain,
To drive my pining flock athwart the plain
To diftant Cam. Fine gain at length, I trow,
To hoard up to myfelf fuch deal of wo!
My fheep quite fpent through travel and ill fare,
And like their keeper ragged grown and bare,
The damp cold green fward for my nightly bed,
And fome flaunt willow's trunk to reft my head.
Hard is to bear of pinching cold the pain;
And hard is want to the unpractis'd fwain;
But neither want, nor pinching cold, is hard,
To blafting ftorms of calumny compar'd:
Unkind as hail it falls; the pelting fhow'r
Deftroys the tender herb and budding flow'r.
Th. Slander we fhepherds count the vileft wrong:
And what wounds forer than an evil tongue?
Co. Untoward lads, the wanton imps of fpite
Make mock of all the ditties I endite.
In vain, O Colinet, thy pipe, fo fhrill,
Charms every vale, and gladdens every hill:
In vain thou feek'ft the coverings of the grove,
In the cool fhade to fing the pains of love:
Sing what thou wilt, ill-nature will prevail;
And every elf hath fkill enough to rail.
But yet, though poor and artlefs be my vein,
Menalcas feems to like my fimple ftrain:
And while that he delighteth in my fong,
Which to the good Menalcas doth belong,
Nor night nor day fhall my rude mufic ceafe;
I afk no more, fo I Menalcas pleafe.
Th. Menalcas, lord of thefe fair fertile plains,
Preferves the fheep, and o'er the fhepherds reigns:
For him our yearly wakes and feafts we hold,
And choofe the faireft firftlings from the fold;
He, good to all who good deferves, fhall give
Thy flock to feed, and thee at eafe to live,
Shall curb the malice of unbridled tongues,
And bounteoufly reward thy rural fongs.
Co. Firft then fhall lightfome birds forget to fly,
The briny ocean turn to paftures dry,
And every rapid river ceafe to flow,
Ere I unmindful of Menalcas grow.
Th. This night thy care with me forget, and fold
Thy flock with mine, to ward th' injurious cold.
New milk, and clouted cream, mild cheefe and curd,
With fome remaining fruit of laft year's hoard,
Sall be our ev'ning fare; and, for the night,
Sweet herbs and mofs, which gentle fleep invite:
And now behold the fun's departing ray,
O'er yonder hill, the fign of ebbing day:
With fongs the jovial hinds return from plow;
And unyok'd heifers, loitering homeward, low.

Paftoral.

Mr Pope's Paftorals next appeared, but in a different drefs from thofe of Spenfer and Philips; for he has difcarded all antiquated words, drawn his fwains more modern and polite, and made his numbers exquifitely harmonious: his eclogues therefore may be called *better poems*, but not better paftorals. We fhall infert the eclogue he has infcribed to Mr Wycherly, the beginning of which is in imitation of Virgil's firft paftoral.

Beneath the fhade a fpreading beech difplays, 143. Pope.
Hylas and Ægon fung their rural lays:
This mourn'd a faithlefs, that an abfent love,
And Delia's name and Doris fill'd the grove.
Ye Mantuan nymphs, your facred fuccour bring;
Hylas and Ægon's rural lays I fing.
Thou, whom the nine with Plautus' wit infpire,
The art of Terence, and Menander's fire:
Whofe fenfe inftructs us, and whofe humour charms,
Whofe judgment fways us, and whofe fpirit warms!
Oh, fkill'd in nature! fee the hearts of fwains,
Their artlefs paffions, and their tender pains.
Now fetting Phœbus fhone ferenely bright,
And fleecy clouds were ftreak'd with purple light;
When tuneful Hylas, with melodious moan,
Taught rocks to weep, and made the mountains groan.
Go, gentle gales, and bear my fighs away!
To Delia's ear the tender notes convey.
As fome fad turtle his loft love deplores,
And with deep murmurs fills the founding fhores;
Thus, far from Delia, to the winds I mourn,
Alike unheard, unpity'd, and forlorn.
Go, gentle gales, and bear my fighs along!
For her the feather'd quires neglect their fong;
For her, the limes their pleafing fhades deny;
For her, the lilies hang their head and die.

Paſtoral.

Ye flow'rs, that droop, forſaken by the ſpring;
Ye birds, that left by ſummer ceaſe to ſing;
Ye trees, that fade when autumn-heats remove;
Say, is not abſence death to thoſe who love?
 Go, gentle gales, and bear my ſighs away!
Curs'd be the fields that cauſe my Delia's ſtay:
Fade ev'ry bloſſom, wither ev'ry tree,
Die ev'ry flow'r and periſh all but ſhe.
What have I ſaid? where'er my Delia flies,
Let ſpring attend, and ſudden flow'rs ariſe;
Let opening roſes knotted oaks adorn,
And liquid amber drop from ev'ry thorn.
 Go, gentle gales, and bear my ſighs along!
The birds ſhall ceaſe to tune their ev'ning ſong,
The winds to breathe, the waving woods to move,
And ſtreams to murmur, ere I ceaſe to love.
Not bubbling fountains to the thirſty ſwain,
Not balmy ſleep to lab'rers faint with pain,
Not ſhow'rs to larks, or ſunſhine to the bee,
Are half ſo charming as thy ſight to me.
 Go, gentle gales, and bear my ſighs away!
Come, Delia, come! ah, why this long delay?
Through rocks and caves the name of Delia ſounds;
Delia, each cave and echoing rock rebounds.
Ye pow'rs, what pleaſing frenzy ſooths my mind!
Do lovers dream, or is my Delia kind?
She comes, my Delia comes!—now ceaſe, my lay;
And ceaſe, ye gales to bear my ſighs away!
 Next Ægon ſung, while Windſor groves admir'd;
Rehearſe, ye muſes, what yourſelves inſpir'd.
 Reſound, ye hills, reſound my mournful ſtrain!
Of perjur'd Doris, dying, I complain:
Here where the mountains, leſs'ning as they riſe,
Loſe the low vales, and ſteal into the ſkies;
While lab'ring oxen, ſpent with toil and heat,
In their looſe traces from the field retreat;
While curling ſmokes from village-tops are ſeen,
And the fleet ſhades glide o'er the duſky green.
 Reſound, ye hills, reſound my mournful lay!
Beneath yon poplar oft we paſs'd the day:
Oft on the rind I carv'd her am'rous vows,
While ſhe with garlands hung the bending boughs:
The garlands fade, the boughs are worn away;
So dies her love, and ſo my hopes decay.
 Reſound, ye hills, reſound my mournful ſtrain!
Now bright Arcturus glads the teeming grain;
Now golden fruits in loaded branches ſhine,
And grateful cluſters, ſwell with floods of wine;
Now bluſhing berries paint the yellow grove:
Juſt Gods! ſhall all things yield returns but love?
 Reſound, ye hills, reſound my mournful lay!
The ſhepherds cry, "Thy flocks are left a prey."——
Ah! what avails it me the flocks to keep,
Who loſt my heart, while I preſerv'd my ſheep?
Pan came, and aſk'd, what magic caus'd my ſmart,
Or what ill eyes malignant glances dart?
What eyes but hers, alas! have pow'r to move?
And is there magic but what dwells in love?
 Reſound, ye hills, reſound my mournful ſtrains!
I'll fly from ſhepherds, flocks, and flow'ry plains.——
From ſhepherds, flocks, and plains, I may remove,
Forſake mankind, and all the world—but love!
I know thee, Love! wild as the raging main,
More fell than tygers on the Libyan plain:
Thou wert from Ætna's burning entrails torn,
Got by fierce whirlwinds, and in thunder born.
 Reſound, ye hills, reſound my mournful lay!
Farewel, ye woods, adieu the light of day!
One leap from yonder cliff ſhall end my pains.
No more, ye hills, no more reſound my ſtrains!
 Thus ſung the ſhepherds till th' approach of night,
The ſkies yet bluſhing with departing light,
When falling dews with ſpangles deck'd the glade,
And the low ſun had lengthen'd ev'ry ſhade.

To theſe paſtorals, which are written agreeably to the taſte of antiquity, and the rules above preſcribed, we ſhall beg leave to ſubjoin another that may be called *burleſque paſtoral*, wherein the ingenious author, Mr Gay, has ventured to deviate from the beaten road, and deſcribed the ſhepherds and ploughmen of our own time and country, inſtead of thoſe of the golden age, to which the modern critics confine the paſtoral. His ſix paſtorals, which he calls the *Shepherd's Week*, are a beautiful and lively repreſentation of the manners, cuſtoms, and notions of our ruſtics. We ſhall inſert the firſt of them, intitled *The Squabble*, wherein two clowns try to outdo each other in ſinging the praiſes of their ſweethearts, leaving it to a third to determine the controverſy. The perſons named are *Lobbin Clout*, *Cuddy*, and *Cloddipole*.

 Lob. Thy younglings, Cuddy, are but juſt awake;
No throſtle ſhrill the bramble-buſh forſake;
No chirping lark the welkin ſheen * invokes;
No damſel yet the ſwelling udder ſtrokes;
O'er yonder hill does ſcant † the dawn appear;
Then why does Cuddy leave his cott ſo rear ‡?
 Cud. Ah Lobbin Clout! I ween || my plight is gueſt;
For *he that loves, a ſtranger is to reſt.*
If ſwains belye not, thou haſt prov'd the ſmart,
And Blouzalinda's miſtreſs of thy heart.
This riſing tear betokeneth well thy mind;
Thoſe arms are folded for thy Blouzalind.
And well, I trow, our piteous plights agree;
Thee Blouzalinda ſmites, Buxoma me.
 Lob. Ah Blouzalind! I love thee more by half,
Than deer their fawns, or cows the new-fall'n calf.
Woe worth the tongue, may bliſters ſore it gall,
That names *Buxoma Blouzalind* withal!
 Cud. Hold, witleſs Lobbin Clout, I thee adviſe,
Leſt bliſters ſore on thy own tongue ariſe.
Lo yonder Cloddipole, the blithſome ſwain,
The wiſeſt lout of all the neighb'ring plain!
From Cloddipole we learnt to read the ſkies,
To know when hail will fall or winds ariſe.
He taught us erſt * the heifer's tail to view,
When ſtuck aloft, that ſhow'rs would ſtraight enſue:
He firſt that uſeful ſecret did explain,
That pricking corns foretold the gath'ring rain.
When ſwallows fleet ſoar high and ſport in air,
He told us that the welkin would be clear.
Let Cloddipole then hear us twain rehearſe,
And praiſe his ſweetheart in alternate verſe.
I'll wager this ſame oaken ſtaff with thee,
That Cloddipole ſhall give the prize to me.
 Lob. See this tobacco-pouch, that's lin'd with hair,
Made of the ſkin of ſleekeſt fallow-deer:
This pouch, that's tied with tape of reddeſt hue,
I'll wager, that the prize ſhall be my due.

Pastoral.

Cud. Begin thy carrols, then, thou vaunting slouch;
Be thine the oaken staff, or mine the pouch.
Lob. My Blouzalinda is the blithest lass,
Than primrose sweeter, or the clover-grass.
Fair is the king-cup that in meadow blows,
Fair is the daisy that beside her grows;
Fair is the gilly-flow'r of gardens sweet;
Fair is the marygold, for pottage meet:
But Blouzalind's than gilly-flow'r more fair,
Than daisy, marygold, or king-cup rare.
Cud. My brown Buxoma is the featest maid
That e'er at wake delightsome gambol play'd;
Clean as young lambkins, or the goose's down,
And like the goldfinch in her Sunday gown.
The witless lamb may sport upon the plain,
The frisking kid delight the gaping swain;
The wanton calf may skip with many a bound,
And my cur Tray play deftest † feats around:
But neither lamb, nor kid, nor calf, nor Tray,
Dance like Buxoma on the first of May.
Lob. Sweet is my toil when Blouzalind is near;
Of her bereft, 'tis winter all the year.
With her no sultry summer's heat I know;
In winter, when she's nigh, with love I glow.
Come, Blouzalinda, ease thy swain's desire,
My summer's shadow, and my winter's fire!
Cud. As with Buxoma once I work'd at hay,
E'en noon-tide labour seem'd an holiday;
And holidays, if haply she were gone,
Like worky-days I wish'd would soon be done.
Eftsoons ‡, O sweetheart kind, my love repay,
And all the year shall then be holiday.
Lob. As Blouzalinda, in a gamesome mood,
Behind a hay-cock loudly laughing stood,
I slily ran and snatch'd a hasty kiss;
She wip'd her lips, nor took it much amiss.
Believe me, Cuddy, while I'm bold to say,
Her breath was sweeter than the ripen'd hay.
Cud. As my Buxoma, in a morning fair,
With gentle finger stroak'd her milky care,
I quaintly ‖ stole a kiss; at first, 'tis true,
She frown'd, yet after granted one or two.
Lobbin, I swear, believe who will my vows,
Her breath by far excell'd the breathing cows.
Lob. Leek to the Welch, to Dutchmen butter's dear,
Of Irish swains potatoes are the cheer;
Oats for their feasts the Scottish shepherds grind,
Sweet turnips are the food of Blouzalind:
While she loves turnips, butter I'll despise,
Nor leeks, nor oatmeal, nor potatoes prize.
Cud. In good roast beef my landlord sticks his knife,
The capon fat delights his dainty wife;
Pudding our parson eats, the squire loves hare;
But white-pot thick is my Buxoma's fare.
While she loves white-pot, capon ne'er shall be,
Nor hare, nor beef, nor pudding, food for me.
Lob. As once I play'd at blind man's buff, it hapt
About my eyes the towel thick was wrapt:
I miss'd the swains, and seiz'd on Blouzalind;
True speaks that ancient proverb, Love is blind.
Cud. As at hot-cockles once I laid me down,
And felt the weighty hand of many a clown;
Buxoma gave a gentle tap, and I
Quick rose, and read soft mischief in her eye.
Lob. On two near elms the slacken'd cord I hung;
Now high, now low, my Blouzalinda swung;
With the rude wind her rumpled garment rose,
And show'd her taper leg and scarlet hose.
Cud. Across the fallen oak the plank I laid,
And myself pois'd against the tott'ring maid!
High leapt the plank, and down Buxoma fell;
I spy'd—but faithful sweethearts never tell.
Lob. This riddle, Cuddy, if thou canst, explain,
This wily riddle puzzles every swain:
What flow'r is that which bears the virgin's name,
The richest metal joined with the same * ?
Cud. Answer, thou carle, and judge this riddle right,
I'll frankly own thee for a cunning wight:
What flow'r is that which royal honour craves,
Adjoin the virgin, and 'tis strown on graves † ?
Clod. Forbear, contending louts, give o'er your strains;
An oaken staff each merits for his pains.
But see the sun-beams bright to labour warn,
And gild the thatch of goodman Hodge's barn.
Your herds for want of water stand a-dry;
They're weary of your songs—and so am I.

* Mary-gold.

† Rose-mary.

We have given the rules usually laid down for pastoral writing, and exhibited some examples written on this plan; but we have to observe, that this poem may take very different forms. It may appear either as a comedy or as a ballad. As a pastoral comedy, there is perhaps nothing which possesses equal merit with Ramsay's *Gentle Shepherd*, and we know not where to find in any language a rival to the *Pastoral Ballad* of Shenstone. That the excellence of this poem is great can hardly be questioned, since it compelled a critic, who was never lavish of his praise, and who on all occasions was ready to vilify the pastoral, to express himself in terms of high encomium. "In the first part (says he) are two passages, to which if any mind denies its sympathy, it has no acquaintance with love or nature:

145 Shenstone.

I priz'd every hour that went by,
Beyond all that had pleas'd me before;
But now they are past, and I sigh,
And I grieve that I priz'd them no more.
When forc'd the fair nymph to forego,
What anguish I felt in my heart!
Yet I thought—but it might not be so,
'Twas with pain that she saw me depart.
She gaz'd, as I slowly withdrew,
My path I could hardly discern;
So sweetly she bade me adieu,
I thought that she bade me return.

"In the second (continues the same critic) this passage has its prettiness, though it be not equal to the former:"

I have found out a gift for my fair;
I have found where the wood-pigeons breed:
But let me that plunder forbear,
She would say 'twas a barbarous deed:
For he ne'er could be true, she aver'd,
Who could rob a poor bird of its young;
And I lov'd her the more when I heard
Such tenderness fall from her tongue.

Sect. V. *Of Didactic or Preceptive Poetry.*

146 Origin and use of didactic poetry.

The method of writing precepts in verse, and embellishing them with the graces of poetry, had its rise, we may suppose, from a due consideration of the frailties

Didactic.

ties and perverseness of human nature; and was intended to engage the affections, in order to improve the mind and amend the heart.

Didactic or preceptive poetry, has been usually employed either to illustrate and explain our moral duties, our philosophical inquiries, our business and pleasures; or in teaching the art of criticism or poetry itself. It may be adapted, however, to any other subject; and may in all cases, where instruction is designed, be employed to good purpose. Some subjects, indeed, are more proper than others, as they admit of more poetical ornaments, and give a greater latitude to genius: but whatever the subject is, those precepts are to be laid down that are the most useful; and they should follow each other in a natural easy method, and be delivered in the most agreeable engaging manner. What the prose writer tells you ought to be done, the poet often conveys under the form of a narration, or shows the necessity of in a description; and by representing the action as done, or doing, conceals the precept that should enforce it. The poet likewise, instead of telling the whole truth, or laying down all the rules that are requisite, selects such parts only as are the most pleasing, and communicates the rest indirectly, without giving us an open view of them; yet takes care that nothing shall escape the reader's notice with which he ought to be acquainted. He discloses just enough to lead the imagination into the parts that are concealed; and the mind, ever gratified with its own discoveries, is complimented with exploring and finding them out; which, though done with ease, seems so considerable, as not to be obtained but in consequence of its own adroitness and sagacity.

147
Rules to be observed in its composition.

But this is not sufficient to render didactic poetry always pleasing: for where precepts are laid down one after another, and the poem is of considerable length, the mind will require some recreation and refreshment by the way; which is to be procured by seasonable moral reflections, pertinent remarks, familiar similies, and descriptions naturally introduced, by allusions to ancient histories or fables, and by short and pleasant digressions and excursions into more noble subjects, so aptly brought in, that they may seem to have a remote relation, and be of a piece with the poem. By thus varying the form of instruction, the poet gives life to his precepts, and awakens and secures our attention, without permitting us to see by what means we are thus captivated: and his art is the more to be admired, because it is so concealed as to escape the reader's observation.

The style, too, must maintain a dignity suitable to the subject, and every part be drawn in such lively colours, that the things described may seem as if presented to the reader's view.

But all this will appear more evident from example; and though entire poems of this kind are not within the compass of our design, we shall endeavour to select such passages as will be sufficient to illustrate the rules we have here laid down.

We have already observed, that, according to the usual divisions, there are four kinds of didactic poems, viz. those that respect our moral duties, our philosophical speculations, our business and pleasures, or that give precepts for poetry and criticism.

I. On the first subject, indeed, we have scarce any thing that deserves the name of poetry, except Mr Pope's *Essay on Man*, his *Ethic Epistles*, Blackmore's *Creation*, and part of Young's *Night Thoughts*; to which therefore we refer as examples.

II. Those preceptive poems that concern philosophical speculations, though the subject is so pregnant with matter, affords such a field for fancy, and is so capable of every decoration, are but few. Lucretius is the most considerable among the ancients who has written in this manner; among the moderns we have little else but small detached pieces, except the poem called *Anti-Lucretius*, which has not yet received an English dress; Dr Akenside's *Pleasures of the Imagination*, and Dr Darwin's *Botanic Garden*; which are all worthy of our admiration. Some of the small pieces in this department are also well executed; and there is one entitled the *Universe*, written by Mr Baker, from which we shall borrow an example.

The author's scheme is in some measure coincident with Mr Pope's, so far especially as it tends to restrain the pride of man, with which design it was professedly written.

The passage we have selected is that respecting the planetary system.

14
Example in didactic poetry.

Unwise! and thoughtless! impotent! and blind!
Can wealth, or grandeur, satisfy the mind?
Of all those pleasures mortals most admire,
Is there one joy sincere, that will not tire?
Can love itself endure? or beauty's charms
Afford that bliss we fancy in its arms?—
Then, let thy soul more glorious aims pursue:
Have thy CREATOR and his works in view.
Be these thy study: hence thy pleasures bring:
And drink large draughts of wisdom from its spring;
That spring, whence perfect joy, and calm repose,
And blest content, and peace eternal, flows.
Observe how regular the planets run,
In stated times, their courses round the Sun.
Diff'rent their bulk, their distance, their career,
And diff'rent much the compass of their year:
Yet all the same eternal laws obey,
While God's unerring finger points the way.
First Mercury, amidst full tides of light,
Rolls next the sun, through his small circle bright.
All that dwell here must be refin'd and pure:
Bodies like ours such ardour can't endure:
Our earth would blaze beneath so fierce a ray,
And all its marble mountains melt away.
Fair Venus, next, fulfils her larger round,
With softer beams, and milder glory crown'd.
Friend to mankind, she glitters from afar,
Now the bright ev'ning, now the morning star.
More distant still, our earth comes rolling on,
And forms a wider circle round the sun:
With her the moon, companion ever dear!
Her course attending through the shining year.
See, Mars, alone, runs his appointed race,
And measures out, exact, the destin'd space:
Nor nearer does he wind, nor farther stray,
But finds the point whence first he roll'd away.
More yet remote from day's all-cheering source,
Vast Jupiter performs his constant course:
Four friendly moons, with borrow'd lustre, rise,
Bestow their beams divine, and light his skies.
Farthest and last, scarce warm'd by Phœbus' ray,
Through his vast orbit Saturn wheels away.

ic. How great the change could we be wafted there!
How flow the feafons! and how long the year!
One moon, on us, reflects its cheerful light:
There, five attendants brighten up the night.
Here, the blue firmament bedeck'd with ftars;
There, over-head, a lucid arch appears.
From hence, how large, how ftrong, the fun's bright ball!
But feen from thence, how languid and how fmall!—
When the keen north with all its fury blows,
Congeals the floods, and forms the fleecy fnows,
'Tis heat intenfe to what can there be known:
Warmer our poles than is its burning zone.
Who there inhabit muft have other pow'rs,
Juices, and veins, and fenfe, and life, than ours.
One moment's cold, like theirs, would pierce the bone,
Freeze the heart-blood, and turn us all to ftone.
Strange and amazing muft the diff'rence be
'Twixt this dull planet and bright Mercury:
Yet reafon fays, nor can we doubt at all,
Millions of beings dwell on either ball,
With conftitutions fitted for that fpot,
Where Providence, all-wife, has fix'd their lot.
Wondrous art thou, O God, in all thy ways!
Their eyes to thee let all thy creatures raife;
Adore thy grandeur, and thy goodnefs praife.
Ye fons of men! with fatisfaction know,
God's own right hand difpenfes all below:
Nor good nor evil does by chance befall;
He reigns fupreme, and he directs it all.
At his command, affrighting human-kind,
Comets drag on their blazing lengths behind:
Nor, as we think, do they at random rove,
But, in determin'd times, through long ellipfes move.
And tho' fometimes they near approach the fun,
Sometimes beyond our fyftem's orbit run;
Throughout their race they act their Maker's will,
His pow'r declare, his purpofes fulfil.

III. Of thofe preceptive poems that treat of the bufinefs and pleafures of mankind, Virgil's *Georgics* claim our firft and principal attention. In thefe he has laid down the rules of hufbandry in all its branches with the utmoft exactnefs and perfpicuity, and at the fame time embellifhed them with all the beauties and graces of poetry. Though his fubject was hufbandry, he has delivered his precepts, as Mr Addifon obferves, not with the fimplicity of a ploughman, but with the addrefs of a poet: the meaneft of his rules are laid down with a kind of grandeur; *and he breaks the clods, and toffes about the dung, with an air of gracefulnefs.* Of the different ways of conveying the fame truth to the mind, he takes that which is pleafanteft; and this chiefly diftinguifhes poetry from profe, and renders Virgil's rules of hufbandry more delightful and valuable than any other.

Thefe poems, which are efteemed the moft perfect of the author's works, are, perhaps, the beft that can be propofed for the young ftudent's imitation in this manner of writing; for the whole of his *Georgics* is wrought up with wonderful art, and decorated with all the flowers of poetry.

IV. Of thofe poems which give precepts for the recreations and pleafures of a country life, we have feveral in our own language that are juftly admired. As the moft confiderable of thofe diverfions, however, are finely treated by Mr Gay in his *Rural Sports*, we particularly refer to that poem.

Didactic.

We fhould here treat of thofe preceptive poems that teach the art of poetry itfelf, of which there are many that deferve particular attention; but we have anticipated our defign, and rendered any farther notice of them in a manner ufelefs, by the obfervations we have made in the courfe of this treatife. We ought however to remark, that Horace was the only poet among the ancients who wrote precepts for poetry in verfe; at leaft his epiftle to the Pifos is the only piece of the kind that has been handed down to us; and that is fo perfect, it feems almoft to have precluded the neceffity of any other. Among the moderns we have feveral that are juftly admired; as Boileau, Pope, &c.

Poets who write in the preceptive manner fhould take care to choofe fuch fubjects as are worthy of their mufe, and of confequence to all mankind; for to beftow both parts and pains to teach people trifles that are unworthy of their attention, is to the laft degree ridiculous.

Among poems of the ufeful and interefting kind, Dr Armftrong's *Art of Preferving Health* deferves particular recommendation, as well in confideration of the fubject, as of the elegant and mafterly manner in which he has treated it; for he has made thofe things, which are in their own nature dry and unentertaining, perfectly agreeable and pleafing, by adhering to the rules obferved by Virgil and others, in the conduct of thefe poems.

149
Its proper ftyle.

With regard to the ftyle or drefs of thefe poems, it fhould be fo rich as to hide the nakednefs of the fubject, and the barrennefs of the precepts fhould be loft in the luftre of the language. "It ought to abound in the moft bold and forcible metaphors, the moft glowing and picturefque epithets; it ought to be elevated and enlivened by pomp of numbers and majefty of words, and by every figure that can lift a language above the vulgar and current expreffions." One may add, that in no kind of poetry (not even in the fublime ode) is beauty of expreffion fo much to be regarded as in this. For the epic writer fhould be very cautious of indulging himfelf in too florid a manner of expreffion, efpecially in the dramatic parts of his fable, where he introduces dialogue: and the writer of tragedy cannot fall into fo naufeous and unnatural an affectation, as to put laboured defcriptions, pompous epithets, ftudied phrafes, and high-flown metaphors, into the mouths of his characters. But as the didactic poet fpeaks in his own perfon, it is neceffary and proper for him to ufe a brighter colouring of ftyle, and to be more ftudious of ornament. And this is agreeable to an admirable precept of Ariftotle, which no writer fhould ever forget,—"That diction ought moft to be laboured in the unactive, that is, the defcriptive, parts of a poem, in which the opinions, manners, and paffions of men are not reprefented; for too glaring an expreffion obfcures the manners and the fentiments."

Warton on Didactic Poetry.

We have already obferved that any thing in nature may be the fubject of this poem. Some things however will appear to more advantage than others, as they give a greater latitude to genius, and admit of more poetical ornaments. Natural hiftory and philofophy are copious fubjects. Precepts in thefe might be

Epistle. be decorated with all the flowers in poetry; and, as Dr Trapp observes, how can poetry be better employed, or more agreeably to its nature and dignity, than in celebrating the works of the great Creator, and describing the nature and generation of animals, vegetables, and minerals; the revolutions of the heavenly bodies; the motions of the earth; the flux and reflux of the sea; the cause of thunder, lightning, and other meteors; the attraction of the magnet; the gravitation, cohesion, and repulsion of matter; the impulsive motion of light; the slow progression of sounds; and other amazing phenomena of nature? Most of the arts and sciences are also proper subjects for this poem; and none are more so than its two sister arts, painting and music. In the former, particularly, there is room for the most entertaining precepts concerning the disposal of colours; the arrangement of lights and shades; the secret attractives of beauty; the various ideas which make up the one; the distinguishing between the attitudes proper to either sex, and every passion; the representing prospects of buildings, battles, or the country; and lastly, concerning the nature of imitation, and the power of painting. What a boundless field of invention is here? What room for description, comparison, and poetical fable? How easy the transition, at any time, from the draught to the original, from the shadow to the substance? and from hence, what noble excursions may be made into history, into panegyric upon the greatest beauties or heroes of the past or present age?

Sect. VI. *Of the Epistle.*

150
The character of the epistle.

This species of writing, if we are permitted to lay down rules from the examples of our best poets, admits of great latitude, and solicits ornament and decoration: yet the poet is still to consider, that the true character of the epistle is ease and elegance; nothing therefore should be forced or unnatural, laboured, or affected, but every part of the composition should breathe an easy, polite, and unconstrained freedom.

It is suitable to every subject; for as the epistle takes place of discourse, and is intended as a sort of distant conversation, all the affairs of life and researches into nature may be introduced. Those, however, which are fraught with compliment or condolence, that contain a description of places, or are full of pertinent remarks, and in a familiar and humorous way describe the manners, vices, and follies of mankind, are the best; because they are most suitable to the true character of epistolary writing, and (business set apart) are the usual subjects upon which our letters are employed.

All farther rules and directions are unnecessary; for this kind of writing is better learned by example and practice than by precept. We shall therefore, in conformity to our plan, select a few epistles for the reader's imitation; which, as this method of writing has of late much prevailed, may be best taken, perhaps, from our modern poets.

The following letter from Mr Addison to Lord Halifax, contains an elegant description of the curiosities and places about Rome, together with such reflections on the inestimable blessings of liberty as must give pleasure to every Briton, especially when he sees them thus placed in direct opposition to the baneful influence of slavery and oppression, which are ever to be seen among the miserable inhabitants of those countries.

Examples in epistolary [...] from [...] ion,

While you, my lord, the rural shades admire,
And from Britannia's public posts retire,
Nor longer, her ungrateful sons to please,
For their advantage sacrifice your ease;
Me into foreign realms my fate conveys,
Through nations fruitful of immortal lays,
Where the soft season and inviting clime
Conspire to trouble your repose with rhime.
For wheresoe'er I turn my ravish'd eyes,
Gay gilded scenes and shining prospects rise,
Poetic fields encompass me around,
And still I seem to tread on classic ground;
For here the muse so oft her harp has strung,
That not a mountain rears its head unsung,
Renown'd in verse each shady thicket grows,
And ev'ry stream in heav'nly numbers flows.
How am I pleas'd to search the hills and woods
For rising springs and celebrated floods;
To view the Nar, tumultuous in his course,
And trace the smooth Clitumnus to his source;
To see the Mincia draw its wat'ry store
Through the long windings of a fruitful shore,
And hoary Albula's infected tide
O'er the warm bed of smoking sulphur glide!
Fir'd with a thousand raptures, I survey
Eridanus thro' flow'ry meadows stray,
The king of floods! that, rolling o'er the plains,
The tow'ring Alps of half their moisture drains,
And, proudly swoln with a whole winter's snows,
Distributes wealth and plenty where he flows.
Sometimes, misguided by the tuneful throng,
I look for streams immortaliz'd in song,
That lost in silence and oblivion lie,
(Dumb are their fountains and their channels dry)
Yet run for ever by the muse's skill,
And in the smooth description murmur still.
Sometimes to gentle Tiber I retire,
And the fam'd river's empty shores admire,
That, destitute of strength, derives its course
From thirsty urns, and an unfruitful source;
Yet sung so often in poetic lays,
With scorn the Danube and the Nile surveys;
So high the deathless muse exalts her theme!
Such was the Boyn, a poor inglorious stream,
That in Hibernian vales obscurely stray'd,
And unobserv'd in wild meanders play'd;
Till, by your lines, and Nassau's sword renown'd,
Its rising billows through the world resound,
Where'er the hero's godlike acts can pierce,
Or where the fame of an immortal verse.
Oh cou'd the muse my ravish'd breast inspire
With warmth like yours, and raise an equal fire,
Unnumber'd beauties in my verse should shine,
And Virgil's Italy should yield to mine!
See how the golden groves around me smile,
That shun the coasts of Britain's stormy isle,
Or when transplanted and preserv'd with care,
Curse the cold clime, and starve in northern air.
Here kindly warmth their mounting juice ferments
To nobler tastes, and more exalted scents:
Ev'n the rough rocks with tender myrtles bloom,
And trodden weeds send out a rich perfume.

Bear-

Bear me, some god, to Baia's gentle seats,
Or cover me in Umbria's green retreats;
Where western gales eternally reside,
And all the seasons lavish all their pride:
Blossoms, and fruits, and flow'rs together rise,
And the whole year in gay confusion lies.
Immortal glories in my mind revive,
And in my soul a thousand passions strive,
When Rome's exalted beauties I descry
Magnificent in piles of ruin lie.
An amphitheatre's amazing height
Here fills my eye with terror and delight,
That on its public shows unpeopled Rome,
And held uncrowded nations in its womb:
Here pillars rough with sculpture pierce the skies;
And here the proud triumphal arches rise,
Where the old Romans deathless acts display'd,
Their base degenerate progeny upbraid:
Whole rivers here forsake the fields below,
And wond'ring at their height thro' airy channels flow.
Still to new scenes my wand'ring muse retires;
And the dumb show of breathing rocks admires;
Where the smooth chissel all its force has shown,
And soften'd into flesh the rugged stone.
In solemn silence, a majestic band,
Heroes, and gods, and Roman consuls stand,
Stern tyrants, whom their cruelties renown,
And emperors in Parian marble frown;
While the bright dames, to whom they humbly su'd,
Still show the charms that their proud hearts subdu'd.
Fain would I Raphael's godlike art rehearse,
And show th' immortal labours in my verse,
Where from the mingled strength of shade and light
A new creation rises to my sight,
Such heav'nly figures from his pencil flow,
So warm with life his blended colours glow.
From theme to theme with secret pleasure tost,
Amidst the soft variety I'm lost.
Here pleasing airs my ravish'd soul confound
With circling notes and labyrinths of sound;
Here domes and temples rise in distant views,
And opening palaces invite my muse.
How has kind heav'n adorn'd the happy land,
And scatter'd blessings with a wasteful hand!
But what avail her unexhausted stores,
Her blooming mountains, and her sunny shores,
With all the gifts that heav'n and earth impart,
The smiles of nature, and the charms of art,
While proud oppression in her valleys reigns,
And tyranny usurps her happy plains?
The poor inhabitant beholds in vain
The red'ning orange and the swelling grain:
Joyless he sees the growing oils and wines,
And in the myrtle's fragrant shade repines:
Starves, in the midst of nature's bounty curst,
And in the loaded vineyard dies for thirst.
O liberty, thou goddess heav'nly bright,
Profuse of bliss, and pregnant with delight!
Eternal pleasures in thy presence reign,
And smiling plenty leads thy wanton train;
Eas'd of her load, subjection grows more light,
And poverty looks cheerful in thy sight;
Thou mak'st the gloomy face of nature gay,
Giv'st beauty to the sun, and pleasure to the day.
Thee, goddess, thee, Britannia's isle adores;
How has she oft exhausted all her stores,
How oft in fields of death thy presence sought,
Nor thinks the mighty prize too dearly bought!
On foreign mountain may the sun refine
The grape's soft juice, and mellow it to wine,
With citron groves adorn a distant soil,
And the fat olive swell with floods of oil:
We envy not the warmer clime, that lies
In ten degrees of more indulgent skies,
Nor at the coarseness of our heav'n repine,
Tho' o'er our heads the frozen Pleiads shine:
'Tis liberty that crowns Britannia's isle,
And makes her barren rocks and her bleak mountains [smile.
Others with tow'ring piles may please the sight,
And in their proud aspiring domes delight;
A nicer touch to the stretch'd canvas give,
Or teach their animated rocks to live:
'Tis Britain's care to watch o'er Europe's fate,
And hold in balance each contending state,
To threaten bold presumptuous kings with war,
And answer her afflicted neighbour's pray'r.
The Dane and Swede, rous'd up by fierce alarms,
Bless the wise conduct of her pious arms:
Soon as her fleets appear, their terrors cease,
And all the northern world lies hush'd in peace.
Th' ambitious Gaul beholds with secret dread
Her thunder aim'd at his aspiring head,
And fain her godlike sons would disunite
By foreign gold, or by domestic spite;
But strives in vain to conquer or divide,
Whom Nassau's arms defend and counsels guide.
Fir'd with the name, which I so oft have found
The distant climes and diff'rent tongues resound,
I bridle in my struggling muse with pain,
That longs to launch into a bolder strain.
But I've already troubled you too long,
Nor dare attempt a more advent'rous song:
My humble verse demands a softer theme,
A painted meadow, or a purling stream;
Unfit for heroes; whom immortal lays,
And lines like Virgil's, or like yours, should praise.

There is a fine spirit of freedom, and love of liberty, displayed in the following letter from Lord Lyttleton to Mr Pope; and the message from the shade of Virgil, which is truly poetical, and justly preceptive, may prove an useful lesson to future bards.

From Rome, 1730.

152 Lyttleton.

Immortal bard! for whom each muse has wove
The fairest garlands of the Aonian grove;
Preserv'd, our drooping genius to restore,
When Addison and Congreve are no more;
After so many stars extinct in night,
The darken'd age's last remaining light!
To thee from Latian realms this verse is writ,
Inspir'd by memory of ancient wit:
For now no more these climes their influence boast,
Fall'n is their glory, and their virtue lost;
From tyrants, and from priests, the muses fly,
Daughters of reason and of liberty.
Nor Baiæ now nor Umbria's plain they love,
Nor on the banks of Nar or Mincia rove;
To Thames's flow'ry borders they retire,
And kindle in thy breast the Roman fire.

 So

Epistle.

So in the shades, where cheer'd with summer rays
Melodious linnets warbled sprightly lays,
Soon as the faded, falling leaves complain
Of gloomy winter's inauspicious reign,
No tuneful voice is heard of joy or love,
But mournful silence saddens all the grove.
Unhappy Italy! whose alter'd state
Has felt the worst severity of fate:
Not that barbarian hands her fasces broke,
And bow'd her haughty neck beneath their yoke;
Nor that her palaces to earth are thrown,
Her cities desert, and her fields unsown;
But that her ancient spirit is decay'd,
That sacred wisdom from her bounds is fled,
That there the source of science flows no more,
Whence its rich streams supply'd the world before.
Illustrious names! that once in Latium shin'd,
Born to instruct and to command mankind;
Chiefs, by whose virtue mighty Rome was rais'd,
And poets, who those chiefs sublimely prais'd!
Oft I the traces you have left explore,
Your ashes visit, and your urns adore;
Oft kiss, with lips devout, some mould'ring stone,
With ivy's venerable shade o'ergrown;
Those hallow'd ruins better pleas'd to see,
Than all the pomp of modern luxury.
As late on Virgil's tomb fresh flow'rs I strow'd,
While with th' inspiring muse my bosom glow'd,
Crown'd with eternal bays, my ravish'd eyes
Beheld the poet's awful form arise:
Stranger, he said, whose pious hand has paid
These grateful rites to my attentive shade,
When thou shalt breathe thy happy native air,
To Pope this message from his master bear.
Great bard, whose numbers I myself inspire,
To whom I gave my own harmonious lyre,
If high exalted on the throne of wit,
Near me and Homer thou aspire to sit,
No more let meaner satire dim the rays
That flow majestic from thy noble bays.
In all the flow'ry paths of Pindus stray:
But shun that thorny, that unpleasing way;
Nor, when each soft engaging muse is thine,
Address the least attractive of the nine.
Of thee more worthy were the task to raise
A lasting column to thy country's praise,
To sing the land, which yet alone can boast
That liberty corrupted Rome has lost;
Where science in the arms of peace is laid,
And plants her palm beneath the olive's shade.
Such was the theme for which my lyre I strung,
Such was the people whose exploits I sung;
Brave, yet refin'd, for arms and arts renown'd,
With diff'rent bays by Mars and Phœbus crown'd,
Dauntless opposers of tyrannic sway,
But pleas'd a mild AUGUSTUS to obey.
If these commands submissive thou receive,
Immortal and unblam'd thy name shall live;
Envy to black Cocytus shall retire,
And howl with furies in tormenting fire;
Approving time shall consecrate thy lays,
And join the patriot's to the poet's praise.

The following letter from Mr Philips to the earl of Dorset is entirely descriptive; but is one of those descriptions which will be ever read with delight.

Copenhagen, March 9. 1709.

FROM frozen climes, and endless tracts of snow,
From streams which northern winds forbid to flow,
What present shall the muse to Dorset bring,
Or how, so near the pole, attempt to sing?
The hoary winter here conceals from sight
All pleasing objects which to verse invite.
The hills and dales, and the delightful woods,
The flow'ry plains, and silver-streaming floods,
By snow disguis'd, in bright confusion lie,
And with one dazzling waste fatigue the eye.
No gentle breathing breeze prepares the spring,
No birds within the desert region sing:
The ships, unmov'd, the boist'rous winds defy,
While rattling chariots o'er the ocean fly.
The vast Leviathan wants room to play,
And spout his waters in the face of day:
The starving wolves along the main sea sprowl,
And to the moon in icy valleys howl.
O'er many a shining league the level main
Here spreads itself into a glassy plain:
There solid billows of enormous size,
Alps of green ice, in wild disorder rise.
And yet but lately have I seen, ev'n here,
The winter in a lovely dress appear.
Ere yet the clouds let fall the treasur'd snow,
Or winds began through hazy skies to blow,
At ev'ning a keen eastern breeze arose,
And the descending rain unsully'd froze;
Soon as the silent shades of night withdrew,
The ruddy morn disclos'd at once to view
The face of nature in a rich disguise,
And brighten'd ev'ry object to my eyes:
For ev'ry shrub, and ev'ry blade of grass,
And ev'ry pointed thorn, seem'd wrought in glass;
In pearls and rubies rich the hawthorns show,
While through the ice the crimson berries glow.
The thick sprung reeds, which watery marshes yield,
Seem'd polish'd lances in a hostile field.
The stag in limpid currents with surprise,
Sees crystal branches on his forehead rise:
The spreading oak, the beech, and tow'ring pine,
Glaz'd over, in the freezing æther shine.
The frighted birds the rattling branches shun,
Which wave and glitter in the distant sun.
When if a sudden gust of wind arise,
The brittle forest into atoms flies,
The crackling woods beneath the tempest bends,
And in a spangled shower the prospect ends:
Or, if a southern gale the region warm,
And by degrees unbend the wint'ry charm,
The traveller a miry country sees,
And journey sad beneath the dropping trees:
Like some deluded peasant Merlin leads
Thro' fragrant bow'rs and thro' delicious meads,
While here enchanted gardens to him rise,
And airy fabrics there attract his eyes,
His wandering feet the magic paths pursue,
And while he thinks the fair illusion true,
The trackless scenes disperse in fluid air,
And woods, and wilds, and thorny ways appear;
A tedious road the weary wretch returns,
And, as he goes, the transient vision mourns.

The great use of medals is properly described in the ensuing elegant epistle from Mr Pope to Mr Addison; and

Philips and

itle. and the extravagant paſſion which ſome people entertain only for the colour of them, is very agreeably and very juſtly ridiculed.

14
pe.

SEE the wild waſte of all devouring years!
How Rome her own ſad ſepulchre appears!
With nodding arches, broken temples ſpread!
The very tombs now vaniſh like their dead!
Imperial wonders rais'd on nations ſpoil'd,
Where mix'd with ſlaves the groaning martyr toil'd!
Huge theatres, that now unpeopled woods,
Now drain'd a diſtant country of her floods!
Fanes, which admiring gods with pride ſurvey,
Statues of men, ſcarce leſs alive than they!
Some felt the ſilent ſtroke of mould'ring age,
Some hoſtile fury, ſome religious rage;
Barbarian blindneſs, Chriſtian zeal conſpire,
And papal piety, and Gothic fire.
Perhaps, by its own ruin ſav'd from flame,
Some bury'd marble half preſerves a name;
That name the learn'd with fierce diſputes purſue,
And give to Titus old Veſpaſian's due.
  Ambition ſigh'd: She found it vain to truſt
The faithleſs column and the crumbling buſt;
Huge moles, whoſe ſhadow ſtretch'd from ſhore to ſhore,
Their ruins periſh'd, and their place no more!
Convinc'd, ſhe now contracts her vaſt deſign,
And all her triumphs ſhrink into a coin.
A narrow orb each crowded conqueſt keeps,
Beneath her palm here ſad Judæa weeps;
Now ſcantier limits the proud arch confine,
And ſcarce are ſeen the proſtrate Nile or Rhine;
A ſmall Euphrates through the piece is roll'd,
And little eagles wave their wings in gold.
  The medal, faithful to its charge of fame,
Through climes and ages bears each form and name:
In one ſhort view ſubjected to our eye,
Gods, emp'rors, heroes, ſages, beauties, lie.
With ſharpen'd ſight pale antiquaries pore,
Th' inſcription value, but the ruſt adore.
This the blue varniſh, that the green endears,
The ſacred ruſt of twice ten hundred years!
To gain Preſcennius one employs his ſchemes,
One graſps a Cecrops in ecſtatic dreams.
Poor Vadius, long with learned ſpleen devour'd,
Can taſte no pleaſure ſince his ſhield was ſcour'd:
And Curio, reſtleſs by the fair one's ſide,
Sighs for an Otho, and neglects his bride.
  Their's is the vanity, the learning thine:
Touch'd by thy hand, again Rome's glories ſhine;
Her gods and god-like heroes riſe to view,
And all her faded garlands bloom anew.
Nor bluſh theſe ſtudies thy regard engage;
Theſe pleas'd the fathers of poetic rage;
The verſe and ſculpture bore an equal part,
And art reflected images to art.
  Oh when ſhall Britain, conſcious of her claim,
Stand emulous of Greek and Roman fame?
In living medals ſee her wars enroll'd,
And vanquiſh'd realms ſupply recording gold?
Here, riſing bold, the patriot's honeſt face;
There, warriors frowning in hiſtoric braſs?
Then future ages with delight ſhall ſee
How Plato's, Bacon's, Newton's, looks agree;
Or in fair ſeries laurell'd bards be ſhown,
A Virgil there, and here an Addiſon.
Then ſhall thy CRAGGS (and let me call him mine)
On the caſt ore, another Pollio ſhine;
With aſpect open ſhall erect his head,
And round the orb in laſting notes be read,
"Stateſman, yet friend to truth! of ſoul ſincere,
"In action faithful, and in honour clear;
"Who broke no promiſe, ſerv'd no private end,
"Who gain'd no title, and who loſt no friend;
"Ennobled by himſelf, by all approv'd,
"Prais'd, wept, and honour'd, by the muſe he lov'd."

Epiſtle.

We have already obſerved, that the eſſential, and indeed the true characteriſtic of epiſtolary writing, is eaſe; and on this account, as well as others, the following letter from Mr Pope to Miſs Blount is to be admired.

To Miſs BLOUNT, on her leaving the Town after the Coronation.

As ſome fond virgin, whom her mother's care
Drags from the town to wholeſome country air;
Juſt when ſhe learns to roll a melting eye,
And hear a ſpark, yet think no danger nigh;
From the dear man unwilling ſhe muſt ſever,
Yet takes one kiſs before ſhe parts for ever:
Thus from the world fair Zephalinda flew,
Saw others happy, and with ſighs withdrew:
Not that their pleaſures caus'd her diſcontent;
She ſigh'd, not that they ſtay'd, but that ſhe went.
  She went, to plain-work, and to purling brooks,
Old-faſhion'd halls, dull aunts, and croaking rooks:
She went from op'ra, park, aſſembly, play,
To morning-walks, and pray'rs three hours a-day;
To part her time 'twixt reading and bohea,
To muſe, and ſpill her ſolitary tea,
Or o'er cold coffee trifle with the ſpoon,
Count the ſlow clock, and dine exact at noon;
Divert her eyes with pictures in the fire,
Hum half a tune, tell ſtories to the 'ſquire;
Up to her godly garret after ſeven,
There ſtarve and pray, for that's the way to heav'n.
  Some 'ſquire, perhaps, you take delight to rack;
Whoſe game is whiſk, whoſe treat's a toaſt in ſack;
Who viſits with a gun, preſents you birds,
Then gives a ſmacking buſs, and cries,—no words!
Or with his hound comes hollowing from the ſtable,
Makes love with nods, and knees beneath a table;
Whoſe laughs are hearty, tho' his jeſts are coarſe,
And loves you beſt of all things—but his horſe.
  In ſome fair ev'ning, on your elbow laid,
You dream of triumphs in the rural ſhade;
In penſive thought recal the fancy'd ſcene,
See coronations riſe on every green;
Before you paſs th' imaginary ſights
Of lords, and earls, and dukes, and garter'd knights,
While the ſpread fan o'erſhades your cloſing eyes:
Then give one flirt, and all the viſion flies.
Thus vaniſh ſceptres, coronets, and balls,
And leave you in lone woods, or empty walls!
  So when your ſlave, at ſome dear idle time,
(Not plagu'd with head-achs, or the want of rhyme)
Stands in the ſtreets, abſtracted from the crew,
And while he ſeems to ſtudy, thinks of you;
Juſt when his fancy points your ſprightly eyes,
Or ſees the bluſh of ſoft Parthenia riſe,

Gay

Descriptive.

Gay pats my shoulder, and you vanish quite,
Streets, chairs, and coxcombs, rush upon my sight;
Vex'd to be still in town, I knit my brow,
Look sour, and hum a tune, as you may now.

Sect. VII. *Of Descriptive Poetry.*

155 Descriptive poetry.

Descriptive poetry is of universal use, since there is nothing in nature but what may be described. As poems of this kind, however, are intended more to delight than to instruct, great care should be taken to make them agreeable. Descriptive poems are made beautiful by similies properly introduced, images of feigned persons, and allusions to ancient fables or historical facts; as will appear by a perusal of the best of these poems, especially Milton's *L'Allegro* and *Il Penseroso*, Denham's *Cooper Hill*, and Pope's *Windsor Forest*. Every body being in possession of Milton's works, we forbear inserting the two former; and the others are too long for our purpose. That inimitable poem, *The Seasons*, by Mr Thomson, notwithstanding some parts of it are didactic, may be also with propriety referred to this head.

Sect. VIII. *Of Allegorical Poetry.*

156 Origin of allegorical poetry.

Could truth engage the affections of mankind in her native and simple dress, she would require no ornament or aid from the imagination; but her delicate light, though lovely in itself, and dear to the most discerning, does not strike the senses of the multitude so as to secure their esteem and attention: the poets therefore dressed her up in the manner in which they thought she would appear the most amiable, and called in allegories and airy disguises as her auxiliaries in the cause of virtue.

An allegory is a fable or story, in which, under the disguise of imaginary persons or things, some real action or instructive moral is conveyed to the mind. Every allegory therefore has two senses, the one literal and the other mystical; the first has been aptly enough compared to a dream or vision, of which the last is the true meaning or interpretation.

157 Its character.

From this definition of allegorical poetry the reader will perceive that it gives great latitude to genius, and affords such a boundless scope for invention, that the poet is allowed to soar beyond all creation; to give life and action to virtues, vices, passions, diseases, and natural and moral qualities; to raise floating islands, enchanted palaces, castles, &c. and to people them with the creatures of his own imagination.

The poet's eye, in a fine frenzy rolling,
Doth glance from heav'n to earth, from earth to heav'n;
And, as imagination bodies forth
The forms of things unknown, the poet's pen
Turns them to shape, and gives to airy nothing
A local habitation and a name. Shakespeare.

But whatever is thus raised by the magic of his mind must be visionary and typical, and the mystical sense must appear obvious to the reader, and inculcate some moral or useful lesson in life; otherwise the whole will be deemed rather the effects of a distempered brain, than the productions of real wit and genius. The poet, like Jason, may sail to parts unexplored, but will meet with no applause if he returns without a golden fleece; for these romantic reveries would be unpardonable but for the mystical meaning and moral that is thus artfully and agreeably conveyed with them, and on which account only the allegory is indulged with a greater liberty than any other sort of writing.

Allegorical.

The ancients justly considered this sort of allegory as the most essential part of poetry; for the power of raising images of things not in being, giving them a sort of life and action, and presenting them as it were before the eyes, was thought to have something in it like creation: but then, in such compositions, they always expected to find a meaning couched under them of consequence; and we may reasonably conclude, that the allegories of their poets would never have been handed down to us, had they been deficient in this respect.

158 Essentials of a just fable.

As the *fable* is the part immediately offered to the reader's consideration, and intended as an agreeable vehicle to convey the moral, it ought to be bold, lively, and surprising, that it may excite curiosity and support attention; for if the fable be spiritless and barren of invention, the attention will be disengaged, and the moral, however useful and important in itself, will be little regarded.

There must likewise be a justness and propriety in the fable, that is, it must be closely connected with the subject on which it is employed; for notwithstanding the boundless compass allowed the imagination in these writings, nothing absurd or useless is to be introduced. In epic poetry some things may perhaps be admitted for no other reason but to surprise, and to raise what is called the *wonderful*, which is as necessary to the epic as the *probable*; but in allegories, however wild and extravagant the fable and the persons introduced, each must correspond with the subject they are applied to, and, like the members of a well-written simile, bear a due proportion and relation to each other: for we are to consider, that the allegory is a sort of extended or rather multiplied simile, and therefore, like that, should never lose the subject it is intended to illustrate. Whence it will appear, that genius and fancy are here insufficient without the aid of taste and judgment: these first, indeed, may produce a multitude of ornaments, a wilderness of sweets; but the last must be employed to accommodate them to reason, and to arrange them so as to produce pleasure and profit.

But it is not sufficient that the fable be correspondent with the subject, and have the properties above described; for it must also be consistent with itself. The poet may invent what story he pleases, and form any imaginary beings that his fancy shall suggest; but here, as in dramatic writings, when persons are once introduced, they must be supported to the end, and all speak and act in character: for notwithstanding the general licence here allowed, some order must be observed; and however wild and extravagant the characters, they should not be absurd. To this let me add, that the whole must be clear and intelligible; for the "fable (as Mr Hughes observes) being designed only to clothe and adorn the moral, but not to hide it, should resemble the draperies we admire in some of the ancient statues, in which the folds are not too many nor too thick, but so judiciously ordered, that the shape and beauty of the limbs may be seen through them."—But this will more obviously appear from a perusal of the

the best compositions of this class; such as Spenser's Fairy Queen, Thomson's Castle of Indolence, Addison and Johnson's beautiful allegories in the Spectator and Rambler, &c. &c.

The word *allegory* has been used in a more extensive sense than that in which we have here applied it: for all writings, where the moral is conveyed under the cover of borrowed characters and actions, by which other characters and actions (that are real) are represented, have obtained the name of *allegories*; though the fable or story contains nothing that is visionary or romantic, but is made up of real or historical persons, and of actions either probable or possible. But these writings should undoubtedly be distinguished by some other name, because the literal sense is consistent with right reason, and may convey an useful moral, and satisfy the reader, without putting him under the necessity of seeking for another.

Some of the ancient critics, as Mr Addison observes, were fond of giving the works of their poets this second or concealed meaning, though there was no apparent necessity for the attempt, and often but little show of reason in the application. Thus the Iliad and Odyssey of Homer are said to be fables of this kind, and that the gods and heroes introduced are only the affections of the mind represented in a visible shape and character. They tell us, says he, that Achilles in the first Iliad represents anger, or the irascible part of human nature: that upon drawing his sword against his superior, in a full assembly, Pallas (which, say they, is another name for reason) checks and advises him on the occasion, and at her first appearance touches him upon the head; that part of the man being looked upon as the seat of reason. In this sense, as Mr Hughes has well observed, the whole Æneis of Virgil may be said to be an allegory, if you suppose Æneas to represent Augustus Cæsar, and that his conducting the remains of his countrymen from the ruins of Troy, to a new settlement in Italy, is an emblem of Augustus's forming a new government out of the ruins of the aristocracy, and establishing the Romans, after the confusion of the civil war, in a peaceable and flourishing condition. However ingenious this coincidence may appear, and whatever design Virgil had in view, he has avoided a particular and direct application, and so conducted his poem, that it is perfect without any allegorical interpretation; for whether we consider Æneas or Augustus as the hero, the morals contained are equally instructive. And indeed it seems absurd to suppose, that because the epic poets have introduced some allegories into their works, every thing is to be understood in a mystical manner, where the sense is plain and evident without any such application. Nor is the attempt that Tasso made to turn his Jerusalem into a mystery, any particular recommendation of the work: for notwithstanding he tells us, in what is called the *allegory*, printed with it, that the Christian army represents man, the city of Jerusalem civil happiness, Godfrey the understanding, Rinaldo and Tancred the other powers of the soul, and that the body is typified by the common soldiers and the like; yet the reader will find himself as little delighted as edified by the explication: for the mind has little pleasure in an allegory that cannot be opened without a key made by the hand of the same artist; and indeed every allegory that is so dark, and, as it were, inexplicable, loses its very essence, and becomes an enigma or riddle, that is left to be interpreted by every crude imagination.

159 The ancient parable.

This last species of writing, whether called an *allegory*, or by any other name, is not less eminent and useful; for the introducing of real or historical persons may not abridge or lessen either our entertainment or instruction. In these compositions we often meet with an uncommon moral conveyed by the fable in a new and entertaining manner; or with a known truth so artfully decorated, and placed in such a new and beautiful light, that we are amazed how any thing so charming and useful should so long have escaped our observation. Such, for example, are many of Johnson's pieces published in the Rambler under the title of *Eastern Stories*, and by Hawkesworth in the Adventurer.

The ancient parables are of this species of writing: and it is to be observed, that those in the New Testament have a most remarkable elegance and propriety; and are the most striking, and the most instructive, for being drawn from objects that are familiar.—The more striking, because, as the things are seen, the moral conveyed becomes the object of our senses, and requires little or no reflection:—the more instructive, because every time they are seen, the memory is awakened, and the same moral is again exhibited with pleasure to the mind, and accustoms it to reason and dwell on the subject. So that this method of instruction improves nature, as it were, into a book of life; since every thing before us may be so managed, as to give lessons for our advantage. Our Saviour's parables of the sower and the seed, of the tares, of the mustard-seed, and of the leaven (Matthew xiii.), are all of this kind, and were obviously taken from the harvest just ripening before him; for *his disciples plucked the ears of corn and did eat, rubbing them in their hands*. See the articles ALLEGORY, and METAPHOR *and Allegory*, in the general alphabet.

SECT. IX. *Of Fables*.

160 The apologue or fable.

No method of instruction has been more ancient, more universal, and probably none more effectual, than that by apologue or fable. In the first ages, amongst a rude and fierce people, this perhaps was the only method that would have been borne; and even since the progress of learning has furnished other helps, the fable, which at first was used through necessity, is retained from choice, on account of the elegant happiness of its manner, and the refined address with which, when well conducted, it insinuates its moral.

As to the actors in this little drama, the fabulist has authority to press into his service every kind of existence under heaven; not only beasts, birds, insects, and all the animal creation; but flowers, shrubs, trees, and all the tribe of vegetables. Even mountains, fossils, minerals, and the inanimate works of nature, discourse articulately at his command, and act the part which he assigns them. The virtues, vices, and every property of beings, receive from him a local habitation and a name. In short, he may personify, bestow life, speech, and action, on whatever he thinks proper.

It it easy to imagine what a source of novelty and variety this must open to a genius capable of conceiving and of employing these ideal persons in a proper manner; what an opportunity it affords him to diver-

Of Fables. ſify his images, and to treat the fancy with changes of objects, while he ſtrengthens the underſtanding, or regulates the paſſions, by a ſucceſſion of truths. To raiſe beings like theſe into a ſtate of action and intelligence, gives the fabuliſt an undoubted claim to that firſt character of the poet, a *creator*.

161 Rules for its conſtruction. When theſe perſons are once raiſed, we muſt carefully enjoin them proper taſks, and aſſign them ſentiments and language ſuitable to their ſeveral natures and reſpective properties. A raven ſhould not be extolled for her voice, nor a bear be repreſented with an elegant ſhape. It were a very obvious inſtance of abſurdity, to paint a hare cruel, or a wolf compaſſionate. An aſs were but ill qualified to be general of an army, though he may well enough ſerve, perhaps, for one of the trumpeters. But ſo long as popular opinion allows to the lion magnanimity, rage to the tiger, ſtrength to the mule, cunning to the fox, and buffoonery to the monkey; why may not they ſupport the characters of an Agamemnon, Achilles, Ajax, Ulyſſes, and Therſites? The truth is, when moral actions are with judgment attributed to the brute creation, we ſcarce perceive that nature is at all violated by the fabuliſt. He appears at moſt to have only tranſlated their language. His lions, wolves, and foxes, behave and argue as thoſe creatures would, had they originally been endowed with the human faculties of ſpeech and reaſon.

But greater art is yet required whenever we perſonify inanimate beings. Here the copy ſo far deviates from the great lines of nature, that, without the niceſt care, reaſon will revolt againſt the fiction. However, beings of this ſort, managed ingeniouſly and with addreſs, recommend the fabuliſt's invention by the grace of novelty and of variety. Indeed the analogy between things natural and artificial, animate and inanimate, is often ſo very ſtriking, that we can, with ſeeming propriety, give paſſions and ſentiments to every individual part of exiſtence. Appearance favours the deception. The vine may be enamoured of the elm; her embraces teſtify her paſſion. The ſwelling mountain may, naturally enough, be delivered of a mouſe. The gourd may reproach the pine, and the ſky-rocket inſult the ſtars. The axe may ſolicit a new handle of the foreſt; and the moon, in her female character, requeſt a faſhionable garment. Here is nothing incongruous; nothing that ſhocks the reader with impropriety. On the other hand, were the axe to deſire a periwig, and the moon petition for a new pair of boots, probability would then be violated, and the abſurdity become too glaring.

The moſt beautiful fables that ever were invented may be diſguſed by the language in which they are clothed. Of this poor Æſop, in ſome of his Engliſh dreſſes, affords a melancholy proof. The ordinary ſtyle of fable ſhould be familiar, but alſo elegant.

162 The proper ſtyle of fable. The familiar, ſays Mr La Motte, is the general tone or accent of fable. It was thought ſufficient, on its firſt appearance, to lend the animals our moſt common language. Nor indeed have they any extraordinary pretenſions to the ſublime; it being requiſite they ſhould ſpeak with the ſame ſimplicity that they behave.

The familiar alſo is more proper for inſinuation than the elevated; this being the language of reflection, as the former is the voice of ſentiment. We guard ourſelves againſt the one, but lie open to the other; and inſtruction will always the moſt effectually ſway us, when it appears leaſt jealous of its rights and privileges.

The familiar ſtyle, however, that is here required, notwithſtanding that appearance of eaſe which is its character, is perhaps more difficult to write than the more elevated or ſublime. A writer more readily perceives when he has riſen above the common language, than he perceives, in ſpeaking this language, whether he has made the choice that is moſt ſuitable to the occaſion: and it is, nevertheleſs, upon this happy choice that all the charms of the familiar depend. Moreover, the elevated ſtyle deceives and ſeduces, although it be not the beſt choſen; whereas the familiar can procure itſelf no ſort of reſpect, if it be not eaſy, natural, juſt, delicate, and unaffected. A fabuliſt muſt therefore beſtow great attention upon his ſtyle; and even labour it ſo much the more, that it may appear to have coſt him no pains at all.

The authority of Fontaine juſtifies theſe opinions in regard to ſtyle. His fables are perhaps the beſt examples of the genteel familiar, as Sir Roger L'Eſtrange affords the groſſeſt of the indelicate and low. When we read, that "while the frog and the mouſe were diſputing it at ſwords-point, down comes a kite powdering upon them in the interim, and gobbets up both together to part the fray;" and "where the fox reproaches a bevy of jolly goſſipping wenches making merry over a diſh of pullets, that if he but peeped into a hen-rooſt, they always made a bawling with their dogs and their baſtards; while you yourſelves (ſays he) can lie ſtuffing your guts with your hens and capons, and not a word of the pudding:" This may be familiar; but it is alſo coarſe and vulgar, and cannot fail to diſguſt a reader that has the leaſt degree of taſte or delicacy.

The ſtyle of fable then muſt be ſimple and familiar; and it muſt likewiſe be correct and elegant. By the former, we mean, that it ſhould not be loaded with figure and metaphor; that the diſpoſition of words be natural, the turn of ſentences eaſy, and their conſtruction unembarraſſed. By elegance, we would exclude all coarſe and provincial terms; all affected and puerile conceits; all obſolete and pedantic phraſes. To this we would adjoin, as the word perhaps implies, a certain finiſhing poliſh, which gives a grace and ſpirit to the whole; and which, though it have always the appearance of nature, is almoſt ever the effect of art.

But notwithſtanding all that has been ſaid, there are ſome occaſions on which it is allowable, and even expedient, to change the ſtyle. The language of a fable muſt riſe or fall in conformity to the ſubject. A lion, when introduced in his regal capacity, muſt hold diſcourſe in a ſtrain ſomewhat more elevated than a country-mouſe. The lioneſs then becomes his queen, and the beaſts of the foreſt are called his ſubjects: a method that offers at once to the imagination both the animal and the perſon he is deſigned to repreſent. Again, the buffoon-monkey ſhould avoid that pomp of phraſe, which the owl employs as her beſt pretence to wiſdom.

re. wiſdom. Unleſs the ſtyle be thus judiciouſly varied, it will be impoſſible to preſerve a juſt diſtinction of character.

Deſcriptions, at once conciſe and pertinent, add a grace to fable; but are then moſt happy when included in the action: whereof the fable of Boreas and the Sun affords us an example. An epithet well choſen is often a deſcription in itſelf; and ſo much the more agreeable, as it the leſs retards us in our purſuit of the cataſtrophe.

Laſtly, little ſtrokes of humour when ariſing naturally from the ſubject, and incidental reflections when kept in due ſubordination to the principal, add a value to theſe compoſitions. Theſe latter, however, ſhould be employed very ſparingly, and with great addreſs; be very few, and very ſhort: it is ſcarcely enough that they naturally ſpring out of the ſubject; they ſhould be ſuch as to appear neceſſary and eſſential parts of the fable. And when theſe embelliſhments, pleaſing in themſelves, tend to illuſtrate the main action, they then afford that nameleſs grace remarkable in Fontaine and ſome few others, and which perſons of the beſt diſcernment will more eaſily conceive than they can explain.

Sect. X. *Of Satire.*

3 n of . This kind of poem is of very ancient date, and (if we believe Horace) was introduced, by way of interlude, by the Greek dramatic poets in their tragedies, to relieve the audience, and take off the force of thoſe ſtrokes which they thought too deep and affecting. In thoſe ſatirical interludes, the ſcene was laid in the country; and the perſons were rural deities, ſatyrs, country peaſants, and other ruſtics.

> The firſt Tragedians found that ſerious ſtyle
> Too grave for their uncultivated age,
> And ſo brought wild and naked Satyrs in
> (Whoſe motion, words, and ſhape, were all a farce)
> As oft as decency wou'd give them leave;
> Becauſe the mad, ungovernable rout,
> Full of confuſion and the fumes of wine,
> Lov'd ſuch variety and antic tricks.
>
> *Roscommon's Horace.*

The ſatire we now have is generally allowed to be of Roman invention. It was firſt introduced without the decorations of ſcenes and action; but written in verſes of different meaſures by Ennius, and afterwards moulded into the form we now have it by Lucilius, whom Horace has imitated, and mentions with eſteem. This is the opinion of moſt of the critics, and particularly of Boileau, who ſays,

> Lucilius led the way, and, bravely bold,
> To Roman vices did the mirror hold;
> Protected humble goodneſs from reproach,
> Show'd worth on foot, and raſcals in a coach.
> Horace his pleaſing wit to this did add,
> That none, uncenſur'd, might be fools or mad:
> And Juvenal, with rhetorician's rage,
> Scourg'd the rank vices of a wicked age;
> Tho' horrid truths thro' all his labours ſhine,
> In what he writes there's ſomething of divine.

Our ſatire, therefore, may be diſtinguiſhed into two kinds; the *jocoſe*, or that which makes ſport with vice and folly, and ſets them up to ridicule; and the *ſerious*, or that which deals in aſperity, and is ſevere and acrimonious. Horace is a perfect maſter of the firſt, and Juvenal much admired for the laſt. The one is facetious, and ſmiles: the other is angry, and ſtorms. The foibles of mankind are the object of one; but crimes of a deeper dye have engaged the other. They both agree, however, in being pungent and biting: and from a due conſideration of the writings of theſe authors, who are our maſters in this art, we may define ſatire to be, A free, (and often jocoſe), witty, and ſharp poem, wherein the follies and vices of men are laſhed and ridiculed in order to their reformation. Its ſubject is whatever deſerves our contempt or abhorrence, (including every thing that is ridiculous and abſurd, or ſcandalous and repugnant to the golden precepts of religion and virtue.) Its manner is *invective*; and its end, *ſhame*. So that ſatire may be looked upon as the phyſician of a diſtempered mind, which it endeavours to cure by bitter and unſavoury, or by pleaſant and ſalutary, applications.

Satire. 164 Definition of it.

165 Qualities of a good ſatiriſt.

A good ſatiriſt ought to be a man of wit and addreſs, ſagacity and eloquence. He ſhould alſo have a great deal of good-nature, as all the ſentiments which are beautiful in this way of writing muſt proceed from that quality in the author. It is good-nature produces that diſdain of all baſeneſs, vice, and folly, which prompts the poet to expreſs himſelf with ſuch ſmartneſs againſt the errors of men, but without bitterneſs to their perſons. It is this quality that keeps the mind even, and never lets an offence unſeaſonably throw the ſatiriſt out of his character.

In writing ſatire, care ſhould be taken that it be true and general; that is, levelled at abuſes in which numbers are concerned: for the perſonal kind of ſatire, or lampoon, which expoſes particular characters, and affects the reputation of thoſe at whom it is pointed, is ſcarce to be diſtinguiſhed from ſcandal and defamation. The poet alſo, whilſt he is endeavouring to correct the guilty, muſt take care not to uſe ſuch expreſſions as may corrupt the innocent: he muſt therefore avoid all obſcene words and images that tend to debaſe and miſlead the mind. Horace and Juvenal, the chief ſatiriſts among the Romans, are faulty in this reſpect, and ought to be read with caution.

166 Proper ſtyle of ſatire.

The ſtyle proper for ſatire is ſometimes grave and animated, inveighing againſt vice with warmth and earneſtneſs; but that which is pleaſant, ſportive, and, with becoming raillery, banters men out of their bad diſpoſitions, has generally the beſt effect, as it ſeems only to play with their follies, though it omits no opportunity of making them feel the laſh. The verſes ſhould be ſmooth and flowing, and the language manly, juſt, and decent.

> Of well-choſe words ſome take not care enough,
> And think they ſhould be as the ſubject rough:
> But ſatire muſt be more exactly made,
> And ſharpeſt thoughts in ſmootheſt words convey'd.
>
> Duke of *Bucks's Essay.*

Satires, either of the *jocoſe* or *ſerious* kind, may be written in the epiſtolary manner, or by way of dialogue. Horace, Juvenal, and Perſius, have given us examples of

Satire.

of both. Nay, some of Horace's satires may, without incongruity, be called *epistles*, and his epistles *satires*. But this is obvious to every reader.

Of the facetious kind, the second satire of the second book of Horace imitated by Mr Pope, and Swift's verses on his own death, may be referred to as examples.

As to those satires of the serious kind, for which Juvenal is so much distinguished, the characteristic properties of which are, morality, dignity, and severity; a better example cannot be mentioned than the poem entitled *London*, written in imitation of the third satire of Juvenal, by Dr Johnson, who has kept up to the spirit and force of the original.

Nor must we omit to mention Dr Young's *Love of Fame the Universal Passion*, in seven satires; which, though characteristical, abound with morality and good sense. The characters are well selected, the ridicule is high, and the satire well pointed and to the purpose.

We have already observed, that personal satire approaches too near defamation, to deserve any countenance or encouragement. Dryden's *Mack Flecknoe* is for this reason exceptionable, but as a composition it is inimitable.

167 Benefits of well-conducted satire.

We have dwelt thus long on the present subject, because there is reason to apprehend, that the benefits arising from well-conducted satire have not been sufficiently considered. A satire may often do more service to the cause of religion and virtue than a sermon; since it gives pleasure, at the same time that it creates fear or indignation, and conveys its sentiments in a manner the most likely to captivate the mind.

> Of all the ways that wisest men could find
> To mend the age and mortify mankind,
> Satire well writ has most successful prov'd,
> And cures, because the remedy is lov'd.
>
> Duke of *Bucks's* Essay.

But to produce the desired effect, it must be jocose, free, and impartial, though severe. The satirist should always preserve good-humour; and, however keen he cuts, should cut with kindness. When he loses temper, his weapons will be inverted, and the ridicule he threw at others will retort with contempt upon himself: for the reader will perceive that he is angry and hurt, and consider his satire as the effect of malice, not of judgement; and that it is intended rather to wound persons than reform manners.

> Rage you must hide, and prejudice lay down:
> A satyr's smile is sharper than his frown.

The best, and indeed the only, method to expose vice and folly effectually, is to turn them to ridicule, and hold them up for public contempt; and as it most offends these objects of satire, so it least hurts ourselves. One passion frequently drives out another; and as we cannot look with indifference on the bad actions of men (for they must excite either our wrath or contempt), it is prudent to give way to that which most offends vice and folly, and least affects ourselves; and to sneer and laugh, rather than be angry and scold.

Epigram.

168 Burlesque poetry. Splendid Shilling. Hudibras.

Burlesque poetry, which is chiefly used by way of drollery and ridicule, falls properly to be spoken of under the head of satire. An excellent example of this kind is a poem in blank verse, intitled *The Splendid Shilling*, written by Mr John Philips, which, in the opinion of one of the best judges of the age, is the finest burlesque in the English language. In this poem the author has handled a low subject in the lofty style and numbers of Milton; in which way of writing Mr Philips has been imitated by several, but none have come up to the humour and happy turn of the original. When we read it, we are betrayed into a pleasure that we could not expect; though, at the same time, the sublimity of the style, and gravity of the phrase, seem to chastise that laughter which they provoke.

There is another sort of verse and style, which is most frequently made use of in treating any subject in a ludicrous manner, viz. that which is generally called *Hudibrastic*, from Butler's admirable poem intitled *Hudibras*. Almost every one knows, that this poem is a satire upon the authors of our civil dissensions in the reign of king Charles I. wherein the poet has, with abundance of wit and humour, exposed and ridiculed the hypocrisy or blind zeal of those unhappy times. In short, it is a kind of burlesque epic poem, which, for the oddity of the rhymes, the quaintness of the similies, the novelty of the thoughts, and that fine raillery which runs through the whole performance, is not to be paralleled.

Sect. XI. *Of the Epigram.*

169 Character of the epigram.

The *epigram is a little poem, or composition in verse, treating of one thing only, and whose distinguishing characters are* brevity, beauty, and point.

The word *epigram* signifies "inscription;" for epigrams derive their origin from those inscriptions placed by the ancients on their statues, temples, pillars, triumphal arches, and the like; which, at first, were very short, being sometimes no more than a single word; but afterwards, increasing their length, they made them in verse, to be the better retained by the memory. This short way of writing came at last to be used upon any occasion or subject; and hence the name of *epigram* has been given to any little copy of verses, without regard to the original application of such poems.

Its usual limits are from two to 20 verses, though sometimes it extends to 50; but the shorter, the better it is, and the more perfect, as it partakes more of the nature and character of this kind of poem: besides, the epigram, being only a single thought, ought to be expressed in a little compass, or else it loses its force and strength.

The beauty required in an epigram is an harmony and apt agreement of all its parts, a sweet simplicity, and polite language.

The point is a sharp, lively, unexpected turn of wit, with which an epigram ought to be concluded. There are some critics, indeed, who will not admit the point in an epigram; but require that the thought be equally diffused through the whole poem, which is usually the practice of Catullus, as the former is that of Martial. It is allowed there is more delicacy in the manner of Catullus; but the point is more agreeable to the general taste, and seems to be the chief characteristic of the epigram.

170 Of what subjects admits.

This sort of poem admits of all manner of subjects, provided that brevity, beauty, and point, are preserved;

ved; but it is generally employed either in praiſe or ſatire.

Though the beſt epigrams are ſaid to be ſuch as are compriſed in two or four verſes, we are not to underſtand it as if none can be perfect which exceed thoſe limits. Neither the ancients nor moderns have been ſo ſcrupulous with reſpect to the length of their epigrams; but, however, brevity in general is always to be ſtudied in theſe compoſitions.

For examples of good epigrams in the Engliſh language, we ſhall make choice of ſeveral in the different taſtes we have mentioned; ſome remarkable for their delicate turn and ſimplicity of expreſſion; and others for their ſalt and ſharpneſs, their equivocating pun, or pleaſant alluſion. In the firſt place, take that of Mr Pope, ſaid to be written on a glaſs with the earl of Cheſterfield's diamond-pencil.

Accept a miracle, inſtead of wit;
See two dull lines by Stanhope's pencil writ.

The beauty of this epigram is more eaſily ſeen than deſcribed; and it is difficult to determine, whether it does more honour to the poet who wrote it, or to the nobleman for whom the compliment is deſigned.—The following epigram of Mr Prior is written in the ſame taſte, being a fine encomium on the performance of an excellent painter.

On a Flower, painted by VARELST.

When fam'd Vareſt this little wonder drew,
Flora vouchſaf'd the growing work to view:
Finding the painter's ſcience at a ſtand,
The goddeſs ſnatch'd the pencil from his hand,
And, finiſhing the piece, ſhe ſmiling ſaid,
Behold one work of mine which ne'er ſhall fade.

Another compliment of this delicate kind he has made Mr Howard in the following epigram.

VENUS *Miſtaken.*

When Chloe's picture was to Venus ſhown;
Surpris'd, the goddeſs took it for her own.
And what, ſaid ſhe, does this bold painter mean?
When was I bathing thus, and naked ſeen?
Pleas'd Cupid heard, and check'd his mother's pride:
And who's blind now, mamma? the urchin cry'd.
'Tis Chloe's eye, and cheek, and lip, and breaſt:
Friend Howard's genius fancy'd all the reſt.

Moſt of Mr Prior's epigrams are of this delicate caſt, and have the thought, like thoſe of Catullus, diffuſed through the whole. Of this kind is his addreſs

To CHLOE *Weeping.*

See, whilſt thou weep'ſt, fair Chloe, ſee
The world in ſympathy with thee.
The cheerful birds no longer ſing,
Each drops his head, and hangs his wing.
The clouds have bent their boſom lower,
And ſhed their ſorrow in a ſhow'r.
The brooks beyond their limits flow,
And louder murmurs ſpeak their wo:
The nymphs and ſwains adopt thy cares;
They heave thy ſighs, and weep thy tears.
Fantaſtic nymph! that grief ſhould move
Thy heart obdurate againſt love.
Strange tears! whoſe pow'r can ſoften all
But that dear breaſt on which they fall. Epigram.

The epigram written on the leaves of a fan by Dr Atterbury, late biſhop of Rocheſter, contains a pretty thought, expreſſed with eaſe and conciſeneſs, and cloſed in a beautiful manner.

On a FAN.

Flavia the leaſt and ſlighteſt toy
Can with reſiſtleſs art employ.
This fan in meaner hands would prove
An engine of ſmall force in love:
Yet ſhe, with graceful air and mien,
Not to be told or ſafely ſeen,
Directs its wanton motion ſo,
That it wounds more than Cupid's bow,
Gives coolneſs to the matchleſs dame,
To ev'ry other breaſt a flame.

We ſhall now ſelect ſome epigrams of the biting and ſatirical kind, and ſuch as turn upon the *pun* or *equivoque*, as the French call it: in which ſort the point is more conſpicuous than in thoſe of the former character. 172 For their point.

The following diſtich is an admirable epigram, having all the neceſſary qualities of one, eſpecially point and brevity.

On a Company of bad DANCERS *to good Muſic.*

How ill the motion with the muſic ſuits!
So Orpheus fiddled, and ſo danc'd the brutes.

This brings to mind another epigram upon a bad fiddler, which we ſhall venture to inſert merely for the humour of it, and not for any real excellence it contains.

To a bad FIDDLER.

Old Orpheus play'd ſo well, he mov'd Old Nick;
But thou mov'ſt nothing but thy fiddle-ſtick.

One of Martial's epigrams, wherein he agreeably rallies the fooliſh vanity of a man who hired people to make verſes for him, and publiſhed them as his own, has been thus tranſlated into Engliſh:

Paul, ſo fond of the name of a poet is grown,
With gold he buys verſes, and calls them his own.
Go on, maſter Paul, nor mind what the world ſays,
They are ſurely his own for which a man pays.

Some bad writer having taken the liberty to cenſure Mr Prior, the poet very wittily laſhed his impertinence in this epigram:

While faſter than his coſtive brain indites,
Philo's quick hand in flowing letters writes,
His caſe appears to me like honeſt Teague's,
When he was run away with by his legs.
Phœbus, give Philo o'er himſelf command;
Quicken his ſenſes, or reſtrain his hand:
Let him be kept from paper, pen, and ink;
So he may ceaſe to write, and learn to think.

Mr Weſley has given us a pretty epigram, alluding to a well-known text of Scripture, on the ſetting up a monument in Weſtminſter Abbey, to the memory of the ingenious Mr Butler, author of *Hudibras.*

Epitaph.

While Butler, needy wretch, was yet alive,
No generous patron would a dinner give.
See him when ſtarv'd to death, and turn'd to duſt,
Preſented with a monumental buſt!
The poet's fate is here in emblem ſhown;
He aſk'd for *Bread*, and he receiv'd a *Stone*.

We ſhall cloſe this ſection with an epigram written on the well-known ſtory of Apollo and Daphne, by Mr Smart.

When Phœbus was am'rous and long'd to be rude,
Miſs Daphne cry'd Piſh! and ran ſwift to the wood;
And rather than do ſuch a naughty affair,
She became a fine laurel to deck the god's hair.
The nymph was, no doubt, of a cold conſtitution;
For, ſure, to turn tree was an odd reſolution!
Yet in this ſhe behav'd like a true modern ſpouſe,
For ſhe fled from his arms to diſtinguiſh his brows.

SECT. XII. *Of the Epitaph.*

173 Character of the epitaph.

THESE compoſitions generally contain ſome eulogium of the virtues and good qualities of the deceaſed, and have a turn of ſerioufneſs and gravity adapted to the nature of the ſubject. Their elegance conſiſts in a nervous and expreſſive brevity; and ſometimes they are cloſed with an epigrammatic point. In theſe compoſitions, no mere epithet (properly ſo called) ſhould be admitted; for here illuſtration would impair the ſtrength, and render the ſentiment too diffuſe and languid. Words that are ſynonymous are alſo to be rejected.

Though the true characteriſtic of the epitaph is ſerioufneſs and gravity, yet we may find many that are jocoſe and ludicrous: ſome likewiſe have true metre and rhyme; while others are between proſe and verſe, without any certain meaſure, though the words are truly poetical; and the beauty of this laſt ſort is generally heightened by an apt and judicious antitheſis. We ſhall give examples of each.

The following epitaph on Sir Philip Sydney's ſiſter, the counteſs of Pembroke, ſaid to be written by the famous Ben Jonſon, is remarkable for the noble thought with which it concludes.

174 Epitaphs in verſe, with remarks upon them.

On MARY *Counteſs-dowager of* PEMBROKE.

Underneath this noble marble hearſe,
Lies the ſubject of all verſe,
Sidney's ſiſter, Pembroke's mother:
Death, ere thou haſt kill'd another
Fair, and learn'd, and good as ſhe,
Time ſhall throw a dart at thee.

Take another epitaph of Ben Jonſon's, on a beautiful and virtuous lady, which has been deſervedly admired by very good judges.

Underneath this ſtone doth lie
As much virtue as could die;
Which when alive did vigour give
To as much beauty as could live.

The following epitaph by Dr Samuel Johnſon, on a muſician much celebrated for his performance, will bear a compariſon with theſe, or perhaps with any thing of the kind in the Engliſh language.

Philips! whoſe touch harmonious could remove
The pangs of guilty pow'r and hapleſs love,
Reſt here, diſtreſt by poverty no more;
Find here that calm thou gav'ſt ſo oft before;
Sleep undiſturb'd within this peaceful ſhrine,
Till angels wake thee with a note like thine.

It is the juſt obſervation of an eminent critic, that the beſt ſubject for epitaphs is private virtue; virtue exerted in the ſame circumſtances in which the bulk of mankind are placed, and which, therefore, may admit of many imitators. He that has delivered his country from oppreſſion, or freed the world from ignorance and error, beſides that he ſtands in no need of monumental panegyric, can excite the emulation of a very ſmall number. The bare name of ſuch men anſwers every purpoſe of a long inſcription, becauſe their atchievements are univerſally known, and their fame is immortal.—But the virtues of him who has repelled the temptations of poverty, and diſdained to free himſelf from diſtreſs at the expence of his honour or his conſcience, as they were practiſed in private, are fit to be told, becauſe they may animate multitudes to the ſame firmneſs of heart and ſteadineſs of reſolution. On this account, there are few epitaphs of more value than the following, which was written by Pope on Mrs Corbet, who died of a cancer in her breaſt.

Here reſts a woman, good without pretence,
Bleſt with plain reaſon, and with ſober ſenſe:
No conqueſt ſhe, but o'er herſelf deſir'd;
No arts eſſay'd, but not to be admir'd.
Paſſion and pride were to her ſoul unknown,
Convinc'd that virtue only is our own.
So unaffected, ſo compos'd a mind,
So firm, yet ſoft, ſo ſtrong, yet ſo refin'd,
Heav'n, as its pureſt gold, by tortures try'd;
The ſaint ſuſtain'd it, but the woman dy'd.

This epitaph, as well as the ſecond quoted from Ben Jonſon, has indeed one fault; the name is omitted. The end of an epitaph is to convey ſome account of the dead; and to what purpoſe is any thing told of him whoſe name is concealed? The name, it is true, may be inſcribed by itſelf upon the ſtone; but ſuch a ſhift of the poet is like that of an unſkilful painter, who is obliged to make his purpoſe known by adventitious help.

Amongſt the epitaphs of a punning and ludicrous caſt, we know of none prettier than that which is ſaid to have been written by Mr Prior on himſelf, wherein he is pleaſantly ſatirical upon the folly of thoſe who value themſelves upon account of the long ſeries of anceſtors through which they can trace their pedigree.

Nobles and heralds, by your leave,
Here lie the bones of Matthew Prior,
The ſon of Adam and of Eve:
Let Bourbon or Naſſau go higher.

The following epitaph on a miſer contains a good caution and an agreeable raillery.

Reader, beware immod'rate love of pelf:
Here lies the worſt of thieves, who robb'd himſelf.

But Dr Swift's epitaph on the ſame ſubject is a maſterpiece of the kind.

Beneath

Epitaph. 176 Satirical.

Beneath this verdant hillock lies
Demer, the wealthy and the wise.
His heirs, that he might safely rest,
Have put his carcase in a chest:
The very chest, in which, they say,
His other Self, his money, lay.
And if his heirs continue kind
To that dear self he left behind,
I dare believe that four in five
Will think his better half alive.

We shall give but one example more of this kind, which is a merry epitaph on an old fiddler, who was remarkable (we may *suppose*) for beating time to his own music.

On Stephen *the Fiddler.*

Stephen and time are now both even;
Stephen beat time, now time's beat Stephen.

We are come now to that sort of epitaph which rejects rhyme, and has no certain and determinate measure; but where the diction must be pure and strong, every word have weight, and the antithesis be preserved in a clear and direct opposition. We cannot give a better example of this sort of epitaph than that on the tomb of Mr Pulteney in the cloisters of Westminster-abbey.

Reader,
If thou art a Briton,
Behold this Tomb with Reverence and Regret:
Here lie the Remains of
Daniel Pulteney,
The kindest Relation, the truest Friend,
The warmest Patriot, the worthiest Man.
He exercised Virtues in this Age,
Sufficient to have distinguish'd him even in the best.
Sagacious by Nature,
Industrious by Habit,
Inquisitive with Art;
He gain'd a complete Knowledge of the State of Britain,
Foreign and domestic;
In most the backward Fruit of tedious Experience,
In him the early acquisition of undissipated Youth.
He serv'd the Court several Years:
Abroad, in the auspicious Reign of Queen Anne;
At home, in the Reign of that excellent prince K. George I.
He served his Country always,
At Court independent,
In the Senate unbiass'd,
At every Age, and in every Station:
This was the bent of his generous Soul,
This the business of his laborious Life.
Public Men, and Public Things,
He judged by one constant Standard,
The True Interest of Britain:
He made no other Distinction of Party,
He abhorred all other.
Gentle, humane, disinterested, beneficent,
He created no Enemies on his own Account:
Firm, determin'd, inflexible,
He feared none he could create in the Cause of Britain.
Reader,
In this Misfortune of thy Country lament thy own:
For know,
The Loss of so much private Virtue
Is a public calamity.

That poignant satire, as well as extravagant praise, may be conveyed in this manner, will be seen by the following epitaph written by Dr Arbuthnot on Francis Chartres; which is too well known, and too much admired, to need our commendation.

Here continueth to rot
The Body of FRANCIS CHARTRES,
Who with an inflexible Constancy,
And inimitable Uniformity of Life,
Persisted,
In spite of Age and Infirmities,
In the Practice of every Human Vice,
Excepting Prodigality and Hypocrisy:
His insatiable Avarice exempted him from the first,
His matchless Impudence from the second.
Nor was he more singular
In the undeviating *Pravity* of his *Manners*,
Than successful
In *Accumulating* Wealth:
For, without Trade or Profession,
Without Trust of Public Money,
And without Bribe-worthy Service,
He acquired, or more properly created,
A Ministerial Estate.
He was the only Person of his Time
Who could cheat without the Mask of Honesty
Retain his Primæval Meanness
When possessed of Ten Thousand a-year;
And having daily deserved the Gibbet for what he *did*,
Was at last condemn'd to it for what he *could* not *do*.
Oh indignant reader!
Think not his Life useless to Mankind;
Providence conniv'd at his execrable designs,
To give to After-ages
A conspicuous Proof and Example
Of how small Estimation is Exorbitant Wealth
In the Sight of GOD,
By His bestowing it on the most Unworthy of all Mortals.

We shall conclude this species of poetry with a droll and satirical epitaph written by Mr Pope, which we transcribed from a monument in Lord Cobham's gardens at Stow in Buckinghamshire.

To the Memory
of
Signior Fido,
An *Italian* of good extraction;
Who came into *England*,
Not to bite us, like most of his Countrymen,
But to gain an honest Livelihood.
He hunted not after Fame,
Yet acquir'd it;
Regardless of the Praise of his Friends,
But most sensible of their Love,
Though he liv'd amongst the Great,
He neither learnt nor flatter'd any Vice.
He was no Bigot,
Though he doubted of none of the 39 Articles.
And, if to follow Nature,
And to respect the laws of Society,
Be Philosophy,
He was a perfect Philosopher,
A faithful Friend,
An agreeable Companion,

Verſification.

A loving Huſband,
Diſtinguiſh'd by a numerous offspring,
All which he liv'd to ſee take good Courſes.
In his old Age he retired
To the houſe of a Clergyman in the country,
Where he finiſhed his earthly Race,
And died an Honour and an Example to the whole Species.

Reader,
This Stone is guiltleſs of Flattery;
For he to whom it is inſcrib'd
Was not a Man,
But a
Gre-hound.

Part III. On VERSIFICATION.

On this ſubject it is meant to confine our inquiry to Latin or Greek hexameters, and to French and Engliſh heroic verſe; as the obſervations we ſhall have occaſion to make, may, with proper variations, be eaſily transferred to the compoſition of other ſorts of verſe.

177 Eſſentials of verſe. Before entering upon particulars, it muſt be premiſed in general, that to verſe of every kind five things are of importance. 1ſt, The number of ſyllables that compoſe a line. 2d, The different lengths of ſyllables, *i. e.* the difference of time taken in pronouncing. 3d, The arrangement of theſe ſyllables combined in words. 4th, The pauſes or ſtops in pronouncing. 5th, Pronouncing ſyllables in a high or a low tone. The three firſt mentioned are obviouſly eſſential to verſe: if any of them be wanting, there cannot be that higher degree of melody which diſtinguiſheth verſe from proſe. To give a juſt notion of the fourth, it muſt be obſerved, that pauſes are neceſſary for three different purpoſes:

178 Regulation of pauſes. one, to ſeparate periods, and members of the ſame period, according to the ſenſe: another, to improve the melody of verſe: and the laſt, to afford opportunity for drawing breath in reading. A pauſe of the firſt kind is variable, being long or ſhort, frequent or leſs frequent, as the ſenſe requires. A pauſe of the ſecond kind, being determined by the melody, is in no degree arbitrary. The laſt ſort is in a meaſure arbitrary, depending on the reader's command of breath. But as one cannot read with grace, unleſs, for drawing breath, opportunity be taken of a pauſe in the ſenſe or in the melody, this pauſe ought never to be diſtinguiſhed from the others; and for that reaſon ſhall be laid aſide. With reſpect then to the pauſes of ſenſe and of melody, it may be affirmed without heſitation, that their coincidence in verſe is a capital beauty: but as it cannot be expected, in a long work eſpecially, that every line ſhould be ſo perfect; we ſhall afterward have occaſion to ſee, that, unleſs the reader be uncommonly ſkilful, the pauſe neceſſary for the ſenſe muſt often, in ſome degree, be ſacrificed to the verſe-pauſe, and the latter ſometimes to the former.

The pronouncing ſyllables in a high or low tone contributes alſo to melody. In reading, whether verſe or proſe, a certain tone is aſſumed, which may be called the *key-note;* and in that tone the bulk of the words are ſounded. Sometimes to humour the ſenſe, and ſometimes the melody, a particular ſyllable is ſounded in a higher tone, and this is termed *accenting a ſyllable*, or gracing it with an accent. Oppoſed to the accent is the cadence, which, however, being entirely regulated by the ſenſe, hath no peculiar relation to verſe. The cadence is a falling of the voice below the key-note at the cloſe of every period; and ſo little is it eſſential to verſe, that in correct reading the final ſyllable of every line is accented, that ſyllable only excepted which cloſes the period, where the ſenſe requires a cadence.

Though the five requiſites above mentioned enter the compoſition of every ſpecies of verſe, they are however governed by different rules, peculiar to each ſpecies. Upon quantity only, one general obſervation may be premiſed, becauſe it is applicable to every ſpecies of verſe. 179 Quantity. That ſyllables, with reſpect to the time taken in pronouncing, are long or ſhort; two ſhort ſyllables, with reſpect to time, being preciſely equal to a long one. Theſe two lengths are eſſential to verſe of all kinds; and to no verſe, it is believed, is a greater variety of time neceſſary in pronouncing ſyllables. The voice indeed is frequently made to reſt longer than uſual upon a word that bears an important ſignification; but this is done to humour the ſenſe, and is not neceſſary for melody. A thing not more neceſſary for melody occurs with reſpect to accenting, ſimilar to that now mentioned: A word ſignifying any thing humble, low, or dejected, is naturally, in proſe as well as in verſe, pronounced in a tone below the key-note.

We are now ſufficiently prepared for particulars; beginning with Latin or Greek hexameter, which are the ſame. The obſervations upon this ſpecies of verſe will come under the four following heads; number, arrangement, pauſe, and accent; for as to quantity, what is obſerved above may ſuffice.

180 Hexameter verſes of the Greeks and Romans conſiſt of ſix feet.

I. HEXAMETER Lines, as to time, are all of the ſame length; being equivalent to the time taken in pronouncing twelve long ſyllables or twenty-four ſhort. An hexameter line may conſiſt of ſeventeen ſyllables; and when regular and not ſpondaic it never has fewer than thirteen: whence it follows, that where the ſyllables are many, the plurality muſt be ſhort; where few, the plurality muſt be long.

This line is ſuſceptible of much variety as to the ſucceſſion of long and ſhort ſyllables. It is, however, ſubjected to laws that confine its variety within certain limits: and for aſcertaining theſe limits, grammarians have invented a rule by dactyles and ſpondees, which they denominate *feet.*

Among the ancient Greeks and Romans, theſe feet regulated the pronunciation, which they are far from doing among us; of which the reaſon will be diſcovered from the explanation that we ſhall give of the Engliſh accent. We ſhall at preſent content ourſelves with pointing out the difference between our pronunciation and that of the Romans in the firſt line of Virgil's eclogues, where it is ſcarcely credible how much we pervert the quantity.

Tit'yre tú pat'ulæ rec'ubans ſub teg'mine fági.

It will be acknowledged by every reader who has an ear, that we have placed the accentual marks upon every ſyllable, and the letter of every ſyllable, that an Engliſhman

lishman marks with the *ictus* of his voice when he recites the line. But, as will be seen presently, a syllable which is pronounced with the stress of the voice upon a consonant is uttered in the shortest time possible. Hence it follows, that in this verse, as recited by us, there are but two long syllables, *tú* and *fá*; though it is certain, that, as recited by a Roman, it contained no fewer than eight long syllables.

Tītўrĕ | tŭ pătŭ|lāē rĕcŭ|bāns sūb | tēgmĭnĕ | fāgī.

But though to pronounce it in this manner with the voice dwelling on the vowel of each long syllable would undoubtedly be correct, and preserve the true movement of the verse, yet to an English ear, prejudiced in behalf of a different movement, it sounds so very uncouth, that Lord Kames has pronounced the true feet of the Greek and Roman verses extremely artificial and complex; and has substituted in their stead the following rules, which he thinks more simple and of more easy application. 1st, The line must always commence with a long syllable, and close with two long preceded by two short. 2d, More than two short can never be found together, nor fewer than two. And, 3d, Two long syllables which have been preceded by two short cannot also be followed by two short. These few rules fulfil all the conditions of a hexameter line with relation to order or arrangement. For these again a single rule may be substituted, which has also the advantage of regulating more affirmatively the construction of every part. To put this rule into words with perspicuity, a hint is taken from the twelve long syllables that compose an hexameter line, to divide it into twelve equal parts or portions, being each of them one long syllable or two short. The rule then is: "The 1st, 3d, 5th, 7th, 9th, 11th, and 12th portions, must each of them be one long syllable; the 10th must always be two short syllables; the 2d, 4th, 6th, and 8th, may either be one long or two short." Or to express the thing still more shortly, "The 2d, 4th, 6th, and 8th portions may be one long syllable or two short; the 10th must be two short syllables; all the rest must consist each of one long syllable." This fulfils all the conditions of an hexameter line, and comprehends all the combinations of dactyles and spondees that this line admits.

Next in order comes the pause. At the end of every hexameter line, every one must be sensible of a complete close or full pause; the cause of which follows. The two long syllables preceded by two short, which always close an hexameter line, are a fine preparation for a pause: for long syllables, or syllables pronounced slow, resembling a slow and languid motion tending to rest, naturally incline the mind to rest, or, which is the same, to pause; and to this inclination the two preceding short syllables contribute, which, by contrast, make the slow pronunciation of the final syllables the more conspicuous. Beside this complete close or full pause at the end, others are also requisite for the sake of melody; of which two are clearly discoverable, and perhaps there may be more. The longest and most remarkable succeeds the 5th portion: the other, which, being shorter and more faint, may be called the *semipause*, succeeds the 8th portion. So striking is the pause first mentioned, as to be distinguished even by the rudest ear: the monkish rhymes are evidently built upon it; in which, by an invariable rule, the final word always chimes with that which immediately precedes the pause:

De planctu cudo || metrum cum carmine nudo
Mingere cum bumbis || res est saluberrima lumbis.

The difference of time in the pause and semipause occasions another difference not less remarkable; that it is lawful to divide a word by a semipause, but never by a pause, the bad effect of which is sensibly felt in the following examples:

Effusus labor, at||que inmitis rupta Tyranni
Again:
Observans nido im||plumes detraxit; at illa
Again:
Loricam quam De||moleo detraxerat ipse

The dividing a word by a semipause has not the same bad effect:

Jamque pedem referens || casus e|vaserat omnes.
Again:
Qualis populea || mœrens Philo|mela sub umbra
Again:
Ludere que vellem || calamo per|misit agresti.

Lines, however, where words are left entire, without being divided even by a semipause, run by that means much the more sweetly.

Nec gemere aërea || cessabit | turtur ab ulmo.
Again:
Quadrupedante putrem || sonitu quatit | ungula campum.
Again:
Eurydicen toto || referebant | flumine ripæ.

The reason of these observations will be evident upon the slightest reflection. Between things so intimately connected in reading aloud as are sense and sound, every degree of discord is unpleasant: and for that reason it is a matter of importance to make the musical pauses coincide as much as possible with those of sense; which is requisite more especially with respect to the pause, a deviation from the rule being less remarkable in a semipause. Considering the matter as to melody solely, it is indifferent whether the pauses be at the end of words or in the middle; but when we carry the sense along, it is disagreeable to find a word split into two by a pause, as if there were really two words: and though the disagreeableness here be connected with the sense only, it is by an easy transition of perceptions transferred to the sound; by which means we conceive a line to be harsh and grating to the ear, when in reality it is only so to the understanding.

To the rule that fixes the pause after the 5th portion there is one exception and no more. If the syllable succeeding the 5th portion be short, the pause is sometimes postponed to it:

Pupillis quos dura || premit custodia matrum
Again:
In terras oppressa || gravi sub religione
Again:
Et quorum pars magna || fui; quis talia fando

This contributes to diversify the melody; and, where the words are smooth and liquid, is not ungraceful; as in the following examples:

Formosam

Versification.

Formosam resonare || doces Amaryllida sylvas

Again:

Agricolas, quibus ipsa || procul discordibus armis

If this pause, placed as aforesaid after the short syllable, happen also to divide a word, the melody by these circumstances is totally annihilated. Witness the following line of Ennius, which is plain prose:

Romæ mœnia terru||it impiger | Hannibal armis.

182 Sense.

Hitherto the arrangement of the long and short syllables of an hexameter line and its different pauses have been considered with respect to melody: but to have a just notion of hexameter verse, these particulars must also be considered with respect to sense. There is not perhaps in any other sort of verse such latitude in the long and short syllables; a circumstance that contributes greatly to that richness of melody which is remarkable in hexameter verse, and which made Aristotle pronounce that an epic poem in any other verse would not succeed*. One defect, however, must not be dissembled, that the same means which contribute to the richness of the melody render it less fit than several other sorts for a narrative poem. There cannot be a more artful contrivance, as above observed, than to close an hexameter line with two long syllables preceded by two short: but unhappily this construction proves a great embarrassment to the sense; which will thus be evident. As in general there ought to be a strict concordance between the thought and the words in which it is dressed; so, in particular, every close in the sense ought to be accompanied with a close in the sound. In prose this law may be strictly observed, but in verse the same strictness would occasion insuperable difficulties. Willing to sacrifice to the melody of verse some share of the concordance between thought and expression, we freely excuse the separation of the musical pause from that of the sense during the course of a line; but the close of an hexameter line is too conspicuous to admit this liberty: for which reason there ought always to be some pause in the sense at the end of every hexameter line, were it but such a pause as is marked by a comma; and for the same reason there ought never to be a full close in the sense but at the end of a line, because there the melody is closed. An hexameter line, to preserve its melody, cannot well admit any great relaxation; and yet, in a narrative poem, it is extremely difficult to adhere strictly to the rule even with these indulgences. Virgil, the chief of poets for versification, is forced often to end a line without any close in the sense, and as often to close the sense during the running of a line; though a close in the melody during the movement of the thought, or a close in the thought during the movement of the melody, cannot be agreeable.

* Poet. cap. 25.

183 Observations on the accent.

The accent, to which we proceed, is not less essential than the other circumstances above handled. By a good ear it will be discerned, that in every line there is one syllable distinguishable from the rest by a capital accent: That syllable, being the seventh portion, is invariably long

Nec bene promeritis || capitûr nec | tangitur ira

Again:

Non sibi sed toto || genitûm se | credere mundo

Again:

Qualis spelunca || subitô com|mota columba

In these examples the accent is laid upon the last syllable of a word; which is favourable to the melody in the following respect, that the pause, which for the sake of reading distinctly must follow every word, gives opportunity to prolong the accent. And for that reason, a line thus accented has a more spirited air than when the accent is placed on any other syllable. Compare the foregoing lines with the following.

Alba neque Assyrio || fucâtur | lana veneno

Again:

Panditur interea || domus ômnipo|tentis Olympi

Again:

Olli sedato || respôndit | corde Latinus.

In lines where the pause comes after the short syllable succeeding the 5th portion, the accent is displaced, and rendered less sensible: it seems to be split into two, and to be laid partly on the 5th portion, and partly on the 7th, its usual place; as in

Nuda genu, nodôque || sinûs col|lecta fluentes.

Again:

Formosam resonâre || docês Amar|yllida sylvas.

Beside this capital accent, slighter accents are laid upon other portions; particularly upon the 4th, unless where it consists of two short syllables; upon the 9th, which is always a long syllable; and upon the 11th, where the line concludes with a monosyllable. Such conclusion, by the by, impairs the melody, and for that reason is not to be indulged unless where it is expressive of the sense. The following lines are marked with all the accents.

Ludere quæ vêllem calamô permîsit agresti

Again:

Et duræ quêrcus sudâbunt rôscida mella

Again:

Parturiunt môntes, nascêtur rîdiculûs mus.

184 Order or arrangement not constitute the whole melody of hexameter verse.

Reflecting upon the melody of hexameter verse, we find, that order or arrangement doth not constitute the whole of it: for when we compare different lines, equally regular as to the succession of long and short syllables, the melody is found in very different degrees of perfection; which is not occasioned by any particular combination of dactyles and spondees, or of long and short syllables, because we find lines where dactyles prevail, and lines where spondees prevail, equally melodious. Of the former take the following instance:

Æneadum genitrix hominum divumque voluptas.

Of the latter:

Molli paulatim flavescet campus arista.

What can be more different as to melody than the two following lines, which, however, as to the succession of long and short syllables, are constructed precisely in the same manner?

Spond. Dact. Spond. Spond. Dact. Spond.
Ad talos stola dimissa et circumdata palla. *Hor.*

Spond. Dact. Spond. Spond. Dact. Spond.
Placatumque nitet diffuso lumine cœlum. *Lucret.*

In the former, the pause falls in the middle of a word, which is a great blemish, and the accent is disturbed by a harsh elision of the vowel *a* upon the particle *et*. In the latter, the pauses and the accent are all of them distinct

distinct and full: there is no elision: and the words are more liquid and sounding. In these particulars consists the beauty of an hexameter line with respect to melody; and by neglecting these, many lines in the satires and epistles of Horace are less agreeable than plain prose; for they are neither the one nor the other in perfection. To draw melody from these lines, they must be pronounced without relation to the sense: it must not be regarded that words are divided by pauses, nor that harsh elisions are multiplied. To add to the account, prosaic low-sounding words are introduced; and, which is still worse, accents are laid on them. Of such faulty lines take the following instances.

Candida rectaque sit, munda hactenus sit neque longa.

Jupiter exclamat simul atque audirit; at in se

Custodes, lectica, ciniflones, parasitæ

Optimus est modulator, ut Alfenus Vafer omni

Nunc illud tantum quæram, meritone tibi sit.

These observations on pauses and semi-pauses, and on the structure of an hexameter line, are doubtless ingenious; but it is by no means certain that a strict attention to them would assist any man in the writing of such verses as would have been pleasing to a Roman ear. Many of his Lordship's rules have no other foundation than what rests on our improper mode of accenting Latin words; which to Virgil or Lucretius would probably have been as offensive as the Scotch accent is to a native of Middlesex.

II. Next in order comes English heroic verse; which shall be examined under the heads of *number*, *accent*, *quantity*, *movement*, and *pause*. These have been treated in so clear and masterly a manner by Sheridan in his Art of Reading, that we shall have little more to do than abridge his doctrine, and point out the few instances in which attachment to a system and partiality to his native tongue seem to have betrayed him into error, or at least made him carry to an extreme what is just only when used with moderation.

" Numbers, in the strict sense of the word*, whether with regard to poetry or music, consist in certain impressions made on the ear at stated and regular distances. The lowest species of numbers is a *double* stroke of the same note or sound, repeated a certain number of times, at equal distances. The repetition of the same *single* note in a continued series, and exactly at equal distances, like the tickling of a clock, has in it nothing numerous; but the same note, *twice* struck a certain number of times, with a pause between each *repetition* of double the time of that between the *strokes*, is numerous. The reason is, that the pleasure arising from *numbers*, consists in the observation of *proportion*; now the repetition of the same note, in exactly the *same intervals*, will admit of no proportion. But the same note *twice* struck, with the pause of *one* between the two strokes, and repeated again at the distance of a pause equal to *two*, admits of the proportional measurement in the pauses of *two* to *one*, to which time can be beaten, and is the lowest and simplest species of numbers. It may be exemplified on the drum, as tu`m-tu`m--tu`m-tu`m--tu`m-tu`m, &c.

" The next progression of numbers is, when the same note is repeated, but in such a way as that one makes a more sensible impression on the ear than the other, by being more forcibly struck, and therefore having a greater degree of loudness; as tĭ-tu`m--tĭ-tu`m; or, tu`m-tĭ--tu`m-tĭ: or when two weak notes precede a more forcible one, as tĭ-tĭ-tu`m--tĭ-tĭ-tu`m; or when the weak notes follow the forcible one, tu`m-tĭ-tĭ--tu`m-tĭ-tĭ.

Versification.

" In the first and lowest species of numbers which we have mentioned, as the notes are exactly the same in every respect, there can be no proportion observed but in the time of the pauses. In the second, which rises in a degree just above the other, though the notes are still the same, yet there is a diversity to be observed in their respective loudness and softness, and therefore a measurable proportion of the quantity of sound. In them we must likewise take into consideration the order of the notes, whether they proceed from strong to weak, or from weak to strong; for this diversity of order occasions a great difference in the impressions made upon the ear, and in the effects produced upon the mind. To express the diversity of order in the notes in all its several kinds, the common term *movement* may be used, as the term *measure* will properly enough express the different proportions of time both in the pauses and in the notes."

For it is to be observed, that all notes are not of the same length or on the same key. In poetry, as well as in music, notes may be high or low, flat or sharp; and some of them may be prolonged at pleasure. " Poetic numbers are indeed founded upon the very same principles with those of the musical kind, and are governed by similar laws (see Music). Proportion and order are the sources of the pleasure which we receive from both; and the beauty of each depends upon a due observation of the laws of measure and movement. The essential difference between them is, that the matter of the one is articulate, that of the other inarticulate sounds: but syllables in the one correspond to notes in the other; poetic feet to musical bars; and verses to strains; in a word, they have all like properties, and are governed by laws of the same kind.

" From what has been said, it is evident, that the *essence* of numbers consists in certain impressions made on the mind through the ear at stated and regular distances of time, with an observation of a relative proportion in those distances; and that the other circumstances of long or short in syllables, or diversity of notes in uttering them, are *not* essentials but only *accidents* of poetic numbers. Should this be questioned, the objector might be silenced by having the experiment tried on a drum, on which, although it is incapable of producing long or short, high or low notes, there is no kind of metre which may not be beat. That, therefore, which regulates the series and movement of the impressions given to the ear by the recitation of an English verse, must, when properly disposed, constitute the essence of English poetic numbers; but it is the accent which particularly impresses the sound of certain syllables or letters upon the ear; for in every word there is a syllable or letter accented. The necessity and use of the accent, as well as in prose as in verse, we shall therefore proceed to explain.

" As words may be formed of various numbers of syllables, from one up to eight or nine*, it was necessary that there should be some peculiar mark to distinguish

* *Art of Reading*, vol. i.

Versification.

guish words from disjointed syllables, otherwise speech would be nothing but a continued succession of syllables conveying no ideas. This distinction of one word from another might be made by a perceptible pause at the end of each in speaking, analagous to the distance made between them in writing and in printing. But these pauses would make discourse disgustingly tedious; and though they might render words sufficiently distinct, they would make the meaning of sentences extremely confused. Words might also be distinguished from each other, and from a collection of detached syllables, by an *elevation* or *depression* of the voice upon one syllable of each word; and this, as is well known to the learned, was the practice of the Greeks and Romans. But the English tongue has for this purpose adopted a mark of the easiest and simplest kind, which is called *accent*. By accent is meant, a certain stress of the voice, upon a particular letter of a syllable, which distinguishes it from the rest, and at the same time distinguishes the syllable itself to which it belongs from the other syllables which compose the word. Thus, in the word *hab'it*, the accent upon the *b* distinguishes that letter from the others, and the first syllable from the last; add more syllables to it, and it will still do the same, as *hab'itable*. In the word *accep't*, the *p* is the distinguished letter, and the syllable which contains it the distinguished syllable; but if we add more syllables to it, as in the word *ac'ceptable*, the seat of the accent is changed to the first syllable, of which *c* is the distinguished letter. Every word in our language of more syllables than one has one of the syllables distinguished from the rest in this manner, and every monosyllable has a letter. Thus, in the word *hat'* the *t* is accented, in *háte* the vowel *a*, in *cub'* the *b*, and in *cúbe* the *u*: so that as articulation is the essence of syllables, accent is the essence of words; which without it would be nothing more than a mere succession of syllables."

We have said, that it was the practice of the Greeks and Romans to elevate or depress their voice upon one syllable of each word. In this elevation or depression consisted their accent; but the English accent consists in the mere stress of the voice, without any change of note. "Among the Greeks, all syllables were pronounced either in a high, low, or middle note; or else in a union of the high and low by means of the intermediate. The middle note, which was exactly at an equal distance between the high and the low, was that in which the unaccented syllables were pronounced. But every word had one letter, if a monosyllable; or one syllable, if it consisted of more than one, distinguished from the rest; either by a note of the voice perceptibly higher than the middle note, which was called the *acute accent*; or by a note perceptibly, and in an equal proportion, lower than the middle one, which was called the *grave accent*; or by an union of the acute and grave on one syllable, which was done by the voice passing from the acute, through the middle note, in continuity down to the grave, which was called the *circumflex*."

"Now in pronouncing English words, it is true that one syllable is always distinguished from the rest, but it is not by any perceptible elevation or depression of the voice, any high or low note, that it is done, but merely by dwelling longer upon it, or by giving it a more forcible stroke. When the stress or accent is on the vowel, we dwell longer on that syllable than on the rest; as, in the words *glóry*, *fáther*, *hóly*. When it is on the consonant, the voice, passing rapidly over the vowel, gives a smarter stroke to the consonant, which distinguishes that syllable from others, as in the words *bat'tle*, *hab'it*, *bar'row*."

Having treated so largely of *accent* and *quantity*, the next thing to be considered in verse will be quickly discussed; for in English it depends wholly on the seat of the accent. "When the accent or stress is on the vowel, the syllable is necessarily long, because the accent cannot be made without dwelling on the vowel a longer time than usual. When it is on the consonant, the syllable is short; because the accent is made by passing rapidly over the vowel, and giving a smart stroke of the voice to the following consonant. Thus the words *ad'd*, *led'*, *bid'*, *cub'*, are all short, the voice passing quickly over the vowel to the consonant; but for the contrary reason, the words *áll*, *láid*, *bíde*, *cúbe*, are long; the accent being on the vowels, on which the voice dwells some time before it takes in the sound of the consonant."

"Obvious as this point is, it has wholly escaped the observation of many an ingenious and learned writer. Lord Kames affirms*, that accenting is confined in English heroic verse to the long syllables; for a short syllable (says he) is not capable of an accent: and Dr Forster, who ought to have understood the nature of the English accent better than his Lordship, asks, whether we do not 'employ more time in uttering the *first* syllables of *heavily*, *hastily*, *quickly*, *slowly*; and the *second* in *solicit*, *mistaking*, *researches*, *delusive*, than in the *others*?' To this question Mr Sheridan replies†, that "in some of these words we certainly do as the Doctor supposes; in *hástily*, *slówly*, *mistáking*, *delúsive*, for instance; where the accent being on the vowels renders their sound long: but in all the others, *heav'-ily*, *quick'-ly*, *solis'-it*, *re-sear'-ches*, where the accent is on the consonant, the syllables *heav'*, *quick'*, *lis'*, *ser*, are pronounced as rapidly as possible, and the vowels are all short. In the Scotch pronunciation (continues he) they would indeed be all reduced to an equal quantity, as thus; *hái-vily*, *háis-tily*, *quéek-ly*, *slów-ly*, *so-lée-cit*, *re-sáir-ches*, *de-lú-sive*. But here we see that the four short syllables are changed into four long ones of a different sound, occasioned by their placing the seat of the accent on the vowels instead of the consonants: thus instead of *hev'* they say *háiv*; for *quick'*, *queek*; for *lis'*, *léece*; and for *ser'*, *sáir*.

"It appears therefore, that the quantity of English syllables is adjusted by one easy and simple rule; which is, that when the seat of the accent is on a vowel, the syllable is long; when on a consonant, short; and that all unaccented syllables are short. Without a due observation of quantity in reciting verses there will be no poetic numbers; yet in composing English verses the poet need not pay the least attention to the quantity of his syllables, as measure and movement will result from the observation of other laws, which are now to be explained.

It has been affirmed by a writer* of great authority among the critics, that in English heroic verse every line consists of ten syllables, five short and five long; from which there are but two exceptions, both of them rare.

rare. The firſt is, where each line of a couplet is made eleven ſyllables, by an additional ſhort ſyllable at the end.

> Thére héroes wit's are kep't in pond'rous váſes,
> And beaus' in ſnuff-boxes and tweezer-caſes.

The other exception, he ſays, concerns the ſecond line of a couplet, which is ſometimes ſtretched out to twelve ſyllables, termed an *Alexandrine line.*

> A needleſs Alexandrine ends the ſong,
> That, like a wounded ſnake, drags its ſlow length along.

After what has been juſt ſaid, it is needleſs to ſtop for the purpoſe of pointing out the ingenious author's miſtake reſpecting long and ſhort ſyllables. Every attentive reader of what has been already laid down, muſt perceive, that in the firſt line of the former couplet, though there are no fewer than ſix accented ſyllables when it is properly read, yet of theſe there are but three that are long, *viz.* thoſe which have the accent on the vowel. Our buſineſs at preſent is, to ſhow the falſity of the rule which reſtrains the heroic line to ten ſyllables; and this we ſhall do by producing lines of a greater number.

> And the ſhrill ſounds ran echoing through the wood.

This line, though it conſiſts of eleven ſyllables, and has the laſt of thoſe accented, or, as Lord Kames would ſay, long, is yet undoubtedly a heroic verſe of very fine ſound. Perhaps the advocates for the rule may contend, that the vowel *o* in echoing ought to be ſtruck out by an apoſtrophe; but as no one reads,

> And the ſhrill ſounds ran ech'ing through the wood,

it is ſurely very abſurd to omit in writing what cannot be omitted in utterance. The two following lines have each eleven ſyllables, of which not one can be ſuppreſſed in recitation.

> Their glittering textures of the filmy dew,
> The great hierarchal ſtandard was to move.

Mr Sheridan quotes as a heroic line,

> O'er many a frozen, many a fiery Alp;

and obſerves what a monſtrous line it would appear, if pronounced,

> O'er man' a frozen, man' a fi'ry Alp,

inſtead of that noble verſe, which it certainly is, when all the thirteen ſyllables are diſtinctly uttered. He then produces a couplet, of which the former line has fourteen, and the latter twelve ſyllables.

> And many an amorous, many a humorous lay,
> Which many a bard had chaunted many a day.

That this is a couplet of very fine ſound cannot be controverted; but we doubt whether the numbers of it or of the other quoted line of thirteen ſyllables be truly heroic. To our ears at leaſt there appears a very perceptible difference between the movement of theſe verſes and that of the verſes of Pope or Dryden; and we think, that, though ſuch couplets or ſingle lines may, for the ſake of variety or expreſſion, be admitted into a heroic poem, yet a poem wholly compoſed of them would not be conſidered as heroic verſe. It has a much greater reſemblance to the verſe of Spenſer, which is now broke into two lines, of which the firſt has eight and the ſecond ſix ſyllables. Nothing, however, ſeems to be more evident, from the other quoted inſtances, than that a heroic line is not confined to the ſyllables, and that it is not by the number of ſyllables that an Engliſh verſe is to be meaſured.

Verſification.

But if a heroic verſe in our tongue be not compoſed, as in French, of a certain number of ſyllables, how is it formed? We anſwer by feet, as was the hexameter line of the ancients; though between their feet and ours there is at the ſame time a great difference. The poetic feet of the Greeks and Romans are formed by quantity, thoſe of the Engliſh by ſtreſs or accent. "Though theſe terms are in continual uſe, and in the mouths of all who treat of poetic numbers, very confuſed and erroneous ideas are ſometimes annexed to them. Yet as the knowledge of the peculiar genius of our language with regard to poetic numbers and its characteriſtical difference from others in that reſpect, depends upon our having clear and preciſe notions of thoſe terms, it will be neceſſary to have them fully explained. The general nature of them has been already ſufficiently laid open, and we have now only to make ſome obſervations on their particular effects in the formation of metre.

"No ſcholar is ignorant that quantity is a term which relates to the length or the ſhortneſs of ſyllables, and that a long ſyllable is double the length of a ſhort one. Now the plain meaning of this is, that a long ſyllable takes up double the time in ſounding that a ſhort one does; a fact of which the ear alone can be the judge. When a ſyllable in Latin ends with a conſonant, and the ſubſequent ſyllable commences with one, every ſchool-boy knows that the former is long, to uſe the technical term, by the law of *poſition.* This rule was in pronunciation ſtrictly obſerved by the Romans, who always made ſuch ſyllables long by dwelling on the vowels; whereas the very reverſe is the caſe with us, becauſe a quite contrary rule takes place in Engliſh words ſo conſtructed, as the accent or ſtreſs of the voice is in ſuch caſes always transferred to the conſonant, and the preceding vowel being rapidly paſſed over, that ſyllable is of courſe ſhort.

"The Romans had another rule of proſody, that when one ſyllable ending with a vowel, was followed by another beginning with a vowel, the former ſyllable was pronounced ſhort; whereas in Engliſh there is generally an accent in that caſe on the former ſyllable, as in the word *píous,* which renders the ſyllable long. Pronouncing Latin therefore by our own rule, as in the former caſe, we make thoſe ſyllables ſhort which were founded long by them; ſo in the latter, we make thoſe ſyllables long which with them were ſhort. We ſay *ar'ma* and *virum'que,* inſtead of *ārma* and *virūmque;* *ſcío and túus,* inſtead of *ſciō* and *tuus'.*

"Having made theſe preliminary obſervations, we proceed now to explain the nature of poetic feet. Feet in verſe correſpond to bars in muſic: a certain number of ſyllables connected form a foot in the one, as a certain number of notes make a bar in the other. They are called feet, becauſe it is by their aid that the voice as it were ſteps along through the verſe in a meaſured pace; and it is neceſſary that the ſyllables which mark this regular movement of the voice ſhould in ſome

meaſure

Versification.

measure be distinguished from the others. This distinction, as we have already observed, was made among the ancient Romans, by dividing their syllables into long and short, and ascertaining their quantity by an exact proportion of time in sounding them; the long being to the short as two to one; and the long syllables, being thus the more important, marked the movement of the verse. In English, syllables are divided into accented and unaccented; and the accented syllables being as strongly distinguished from the unaccented, by the peculiar stress of the voice upon them, are as capable of marking the movement, and pointing out the regular paces of the voice, as the long syllables were by their quantity among the Romans. Hence it follows, that our accented syllables corresponding to their long ones, and our unaccented to their short, in the structure of poetic feet, an accented syllable followed by one unaccented in the same foot will answer to their *trochee;* and preceded by an unaccented one, to their *iambus:* and so with the rest.

"All feet used in poetry consist either of two or three syllables; and the feet among the ancients were denominated from the number and quantity of their syllables. The measure of quantity was the short syllable, and the long one in time was equal to two short. A foot could not consist of less than two times, because it must contain at least two syllables; and by a law respecting numbers, which is explained elsewhere (see Music), a poetic foot would admit of no more than four of those times. Consequently the poetic feet were necessarily reduced to eight; four of two syllables, and four of three. Those of two syllables must either consist of two short, called a *pyrrhic;* two long, called a *spondee;* a long and a short, called a *trochee;* or a short and a long, called an *iambus.* Those of three syllables were, either three short, a *tribrach;* a long and two short, a *dactyl;* a short, long, and short, an *amphibrach;* or two short and a long, an *anapæst* (Y).

We are now sufficiently prepared for considering what feet enter into the composition of an English heroic verse.

The Greeks and Romans made use of but two feet in the structure of their hexameters; and the English heroic may be wholly composed of one foot, viz. the *iambic,* which is therefore the foot most congenial to that species of verse. Our poetry indeed abounds with verses into which no other foot is admitted. Such as,

The pow'rs | gave éar | and gránted hálf | his práy'r,
The rest' | the wínds | dispérs'd | in emp|ty áir.

Our heroic line, however, is not wholly restrained to the use of this foot. In the opinion of Mr Sheridan it admits all the eight before enumerated; and it certainly excludes none, unless perhaps the *tribrach.* It is known to every reader of English poetry, that some of the finest heroic verses in our language begin with a *trochee;* and that Pope, the smoothest of all our versifiers, was remarkable for his use of this foot, as is evident from the following example, where four succeeding lines out of six have a trochaic beginning.

Her lively looks a sprightly mind disclose,
Quick' as | her eyes | and as unfix'd as those:
Favours | to none | to all she smiles extends,
O'ft she | rejects | but never once offends.
Bríght as | the sun | her eyes the gazers strike,
And like the sun she shines on all alike.

The use of this foot, however, is not necessarily confined to the beginning of a line. Milton frequently introduces it into other parts of the verse; of which take the following instances:

That áll | was lost' | back' to | the thick'et flunk—
Of E've | whose ey'e | dárted contá|gious fire.

The last line of the following couplet begins with a *pyrrhic:*

She sáid, | and mél|ting as in tears she lay,
In ă | soft sil|ver stream dissolv'd away;

But this foot is introduced likewise with very good effect into other parts of the verse, as

Pánt on | thy lip' | ănd tŏ | thy heárt | be prest.|
The phantom flies me | ăs ŭn|kind as you.
Leaps o'er the fence with ease | intŏ | the fold.
Ănd thĕ | shrill' sounds | ran echoing through the woods.

In this last line we see that the first foot is a *pyrrhic,* and the second a *spondee;* but in the next the two first feet are *spondees.*

Hill's peép | o'ér hill's | and Alps | on Alps | arise.

In the following verse a trochee is succeeded by two spondees, of which the former is a genuine spondee by quantity, and the latter equivalent to a spondee by accent.

Sée thē | bōld yōuth | stráin up' | the threat'ning steep.

We shall now give some instances of lines containing both the *pyrrhic* and the *spondee,* and then proceed to the consideration of the other four feet.

Thāt ŏn | weāk wīngs | from far pursues your flight.
Thrŏ' thĕ | fāir scēne | rōll slōw | the ling'ring streams.
Ŏn hĕr | whīte breast | a sparkling cross she wore.

Of the four trissyllabic feet, the first, of which we shall give instances in heroic lines, is the *dactyl;* as.

Mur'muring, | and with | him' fled | the shades | of night.
Hov'ering

(Y) For the convenience of the less learned reader we shall here subjoin a scheme of poetic feet, using the marks (- ᴗ) in use among the Latin grammarians to denote the genuine feet by quantity; and the following marks (' ᴗ) to denote the English feet by accent which answer to those.

	Roman	English		Roman	English
Trochee	- ᴗ	' ᴗ	Dactyl	- ᴗ ᴗ	' ᴗ ᴗ
Iambus	ᴗ -	ᴗ '	Amphibrach	ᴗ - ᴗ	ᴗ ' ᴗ
Spondee	- -	' '	Anapæst	ᴗ ᴗ -	ᴗ ᴗ '
Pyrrhic	ᴗ ᴗ	ᴗ ᴗ	Tribrach	ᴗ ᴗ ᴗ	ᴗ ᴗ ᴗ

Hov'ering | on wing | un'der | the cápe | of hell'.
Tim'orous | and slothful yet he pleased the ear.
Of trúth | in word | míghtier | than they | in arms.

Of the *anapæst* a single instance shall suffice; for except by Milton it is not often used.

The great | hĭĕrár|chal standard was to move.

The *amphibrach* is employed in the four following verses, and in the three last with a very fine effect.

With wheels | yet hóver ing o'er the ocean brim
Rous'd from their slumber on | thăt fíĕ|ry | couch.
While the | prŏmis'cŭ ous crowd stood yet aloof.
Throws his steep flight | ĭn mány̆ | ăn ai|ry whirl.

Having thus sufficiently proved that the English heroic verse admits of all the feet except the *tribrach*, it may be proper to add, that from the nature of our accent we have duplicates of these feet, viz. such as are formed by quantity, and such as are formed by the mere *ictus* of the voice; an opulence peculiar to our tongue, and which may be the source of a boundless variety. But as feet formed of syllables which have the *accent* or *ictus* on the consonant are necessarily pronounced in less time than similar feet formed by quantity, it may be objected, that the measure of a whole line, constructed in the former manner, must be shorter than that of another line constructed in the latter; and that the intermixture of verses of such different measures in the same poem must have a bad effect on the melody, as being destructive of proportion. This objection would be well-founded, were not the time of the short accented syllables compensated by a small pause at the end of each word to which they belong, as is evident in the following verse:

Then rus'|tling crack'|ling crash|ing thun'|der down.

This line is formed of iambics by accent upon consonants, except the last syllable; and yet by means of these soft pauses or rests, the measure of the whole is equal to that of the following, which consists of pure iambics by quantity.

O'er hēaps | of rūin stālk'd | the state|ly hīnd.

Movement, of so much importance in versification, regards the order of syllables in a foot, measure their quantity. The order of syllables respects their progress from short to long or from long to short, as in the Greek and Latin languages; or from strong to weak or weak to strong, *i. e.* from accented or unaccented syllables, as in our tongue. It has been already observed, that an English heroic verse may be composed wholly of iambics; and experience shows that such verses have a fine melody. But as the stress of the voice, in repeating verses of pure iambics, is regularly on every second syllable, such uniformity would disgust the ear in any long succession, and therefore such changes were sought for as might introduce the pleasure of variety without prejudice to melody; or which might even contribute to its improvement. Of this nature was the introduction of the trochee to form the first foot of an heroic verse, which experience has shown us is so far from spoiling the melody, that in many cases it heightens it. This foot, however, cannot well be admitted into any other part of the verse without prejudice to the melody, because it interrupts and stops the usual movement by another directly opposite. But though it be excluded with regard to pure melody, it may often be admitted into any part of the verse with advantage to expression, as is well known to the readers of Milton.

"The next change admitted for the sake of variety, without prejudice to melody, is the intermixture of pyrrhics and spondees; in which two impressions in the one foot make up for the want of one in the other; and two long syllables compensate two short, so as to make the sum of the quantity of the two feet equal to two iambics. That this may be done without prejudice to the melody, take the following instances:

Ŏn hĕr | whīte brēāst | a sparkling cross she wore.—
Nŏr thĕ | dēēp trāct | of hell—say first what cause.—

This intermixture may be employed *ad libitum*, in any part of the line; and sometimes two spondees may be placed together in one part of the verse, to be compensated by two pyrrhics in another; of which Mr Sheridan quotes the following lines as instances:

Stōōd rūl'd | stōōd vāst | ĭnfĭn|ĭtŭde | confined.
Shē āll | nīght lōng | hĕr ămŏ|rōus dēs|cant sung.

That the former is a proper example, will not perhaps be questioned; but the third foot in the latter is certainly no pyrrhic. As it is marked here and by him, it is a tribrach; but we appeal to our English readers, if it ought not to have been marked an amphibrach by accent, and if the fourth foot be not an iambus. To us the feet of the line appear to be as follow:

Shē āll | nīght lōng | hĕr am'ŏ|rōus des'|cănt sung.

It is indeed a better example of the proper use of the amphibrach than any which he has given, unless perhaps the two following lines:

Up to | thĕ fíĕ|ry con'căve tow'ĕr|ing high.
Thrōws hĭs | stēēp flīght | ĭn man'y̆ | ăn áĭ|ry whirl.

That in these three lines the introduction of the amphibrach does not hurt the melody, will be acknowledged by every person who has an ear; and those who have not, are not qualified to judge. But we appeal to every man of taste, if the two amphibrachs succeeding each other in the last line do not add much to the expression of the verse. If this be questioned, we have only to change the movement to the common iambic, and we shall discover how feeble the line will become.

Throws his | steep flight | in man|y ai|ry whirls.

This is simple description, instead of that magical power of numbers which to the imagination produces the object itself, *whirling* as it were round an axis.

Having thus shown that the iambus, spondee, pyrrhic, and amphibrach, by accent, may be used in our measure with great latitude; and that the trochee may at all times begin the line, and in some cases with advantage to the melody; it now remains only to add, that the dactyl, having the same movement, may be introduced in the place of the trochee; and the anapæst in the place of the iambus. In proof of this, were not the article swelling in our hands, we could adduce many instances which would show what an inexhaustible fund of riches, and what an immense variety of materials, are prepared for us, "to build the lofty rhime." But we hasten

Versification.

hasten to the next thing to be considered in the art of versifying, which is known by the name of *pauses*.

"Of the poetic pauses there are two sorts, the *cesural* and the *final*. The cesural divides the verse into equal or unequal parts; the final closes it. In a verse there may be two or more cesural pauses, but it is evident that there can be but one final. As the final pause concerns the reader more than the writer of verses, it has been seldom treated of by the critics. Yet as it is this final pause which in many cases distinguishes verse from prose, it cannot be improper in the present article to show how it ought to be made. Were it indeed a law of our versification, that every line should terminate with a stop in the sense, the boundaries of the measure would be fixed, and the nature of the final pause could not be mistaken. But nothing has puzzled the bulk of readers, or divided their opinions, more than the manner in which those verses ought to be recited, where the sense does not close with the line; and whose last words have a necessary connection with those that begin the subsequent verse. "Some (says Mr Sheridan) who see the necessity of pointing out the metre, pronounce the last word of each line in such a note as usually accompanies a comma, in marking the smallest member of a sentence. Now this is certainly improper, because it makes that appear to be a complete member of a sentence which is an incomplete one; and by disjoining the sense as well as the words, often confounds the meaning. Others again, but these fewer in number, and of the more absurd kind, drop their voice at the end of every line, in the same note which they use in marking a full stop; to the utter annihilation of the sense. Some readers (continues our author) of a more enthusiastic kind, elevate their voices at the end of all verses to a higher note than is ever used in the stops which divide the meaning. But such a continued repetition of the same high note becomes disgusting by its monotony, and gives an air of chanting to such recitation. To avoid these several faults, the bulk of readers have chosen what they think a safer course, which is that of running the lines one into another without the least pause, where they find none in the sense; but by this mode of recitation they reduce poetry to something worse than prose, to verse run mad.

But it may be asked, if this final pause must be marked neither by an elevation nor by a depression of the voice, how is it to be marked at all? To which Mr Sheridan replies, by making no change whatever in the voice before it. This will sufficiently distinguish it from the other pauses, the comma, semicolon, &c. because some change of note, by raising or depressing the voice, always precedes them, whilst the voice is here only suspended.

Now this pause of suspension is the very thing wanting to preserve the melody at all times, without interfering with the sense. For it perfectly marks the bound of the metre; and being made only by a suspension, not by a change of note in the voice, it never can affect the sense; because the sentential stops, or those which affect the sense, being all made with a change of note, where there is no such change, the sense cannot be affected. Nor is this the only advantage gained to numbers by this stop of suspension. It also prevents the monotony at the end of lines; which, however pleasing to a rude, is disgusting to a delicate, ear. For as this stop has no peculiar note of its own, but always takes that which belongs to the preceding word, it changes continually with the matter, and is as various as the sense.

Having said all that is necessary with regard to the final, we proceed now to consider the cesural pause. To these two pauses it will be proper to give the denomination of *musical*, to distinguish them from the comma, semicolon, colon, and full stop, which may be called *sentential pauses*; the office of the former being to mark the melody, as that of the latter is to point out the sense. The cesural, like the final pause, sometimes coincides with the sentential; and sometimes takes place where there is no stop in the sense. In this last case, it is exactly of the same nature, and governed by the same laws with the pause of suspension, which we have just described.

The cesure, though not essential, is however a great ornament to verse, as it improves and diversifies the melody, by a judicious management in varying its situation; but it discharges a still more important office than this. Were there no cesure, verse could aspire to no higher ornament than that of simple melody; but by means of this pause there is a new source of delight opened in poetic numbers, correspondent in some sort to harmony in music. This takes its rise from that act of the mind which compares the relative proportions that the members of a verse thus divided bear to each other, as well as to those in the adjoining lines. In order to see this matter in a clear light, let us examine what effect the cesure produces in single lines, and afterwards in comparing contiguous lines with each other.

With regard to the place of the cesure, Mr Pope and others have expressly declared, that no line appeared musical to their ears, where the cesure was not after the fourth, fifth, or sixth syllable of the verse. Some have enlarged its empire to the third and seventh syllables; whilst others have asserted that it may be admitted into any part of the line.

"There needs but a little distinguishing (says Mr Sheridan) to reconcile these different opinions. If melody alone is to be considered, Mr Pope is in the right when he fixes its seat in or as near as may be to the middle of the verse. To form lines of the first melody, the cesure must either be at the end of the second or of the third foot, or in the middle of the third between the two. Of this movement take the following examples:

1. Of the cesure at the end of the second foot.

> Our plenteous streams || a various race supply;
> The bright-ey'd perch || with fins of Tyrian dye;
> The silver eel || in shining volumes roll'd;
> The yellow carp || in scales bedrop'd with gold.

2. At the end of the third foot.

> With tender billet-doux || he lights the pyre,
> And breathes three amorous sighs || to raise the fire.

3. Between the two, dividing the third foot.

> The fields are ravish'd || from the industrious swains,
> From men their cities, || and from gods their fanes.

These lines are certainly all of a fine melody, yet they are not quite upon an equality in that respect. Those which have the cesure in the middle are of the first order;

der; thofe which have it at the end of the fecond foot are next; and thofe which have the paufe at the end of the third foot the laft. The reafon of this preference it may not perhaps be difficult to affign.

In the pleafure arifing from comparing the proportion which the parts of a whole bear to each other, the more eafily and diftinctly the mind perceives that proportion, the greater is the pleafure. Now there is nothing which the mind more inftantaneoufly and clearly difcerns, than the divifion of a whole into two equal parts, which alone would give a fuperiority to lines of the firft order over thofe of the other two. But this is not the only claim to fuperiority which fuch lines poffefs. The cefure being in them always on an unaccented, and the final paufe on an accented, fyllable, they have a mixture of variety and equality of which neither of the other orders can boaft, as in thefe orders the cefural and final paufes are both on accented fyllables.

In the divifion of the other two fpecies, if we refpect quantity only, the proportion is exactly the fame, the one being as two to three, and the other as three to two; but it is the order or movement which here makes the difference. In lines where the cefure bounds the fecond foot, the fmaller portion of the verfe is firft in order, the greater laft; and this order is reverfed in lines which have the cefure at the end of the third foot. Now, as the latter part of the verfe leaves the ftrongeft and moft lafting impreffion on the ear, where the larger portion belongs to the latter part of the line, the impreffion muft in proportion be greater; the effect in found being the fame as that produced by a climax in fenfe, where one part rifes above another.

Having fhown in what manner the cefure improves and diverfifies the melody of verfe, we fhall now treat of its more important office, by which it is the chief fource of harmony in numbers. But, firft, it will be neceffary to explain what we mean by the term *harmony*, as applied to verfe.

Melody in mufic regards only the effects produced by fucceffive founds; and harmony, ftrictly fpeaking, the effects produced by different co-exifting founds, which are found to be in concord. Harmony, therefore, in this fenfe of the word, can never be applied to poetic numbers, of which there can be only one reciter, and confequently the founds can only be in fucceffion. When therefore we fpeak of the harmony of verfe, we mean nothing more than an effect produced by an action of the mind in comparing the different members of verfe already conftructed according to the laws of melody with each other, and perceiving a due and beautiful proportion between them.

The firft and loweft perception of this kind of harmony arifes from comparing two members of the fame line with each other, divided in the manner to be feen in the three inftances already given; becaufe the beauty of proportion in the members, according to each of thefe divifions, is founded in nature. But there is a perception of harmony in verfification, which arifes from the comparifon of two lines, and obferving the relative proportion of their members; whether they correfpond exactly to each other by fimilar divifions, as in the couplets already quoted; or whether they are diverfified by cefures in different places. As,

> See the bold youth || ftrain up the threatening fteep,
> Rufh thro' the thickets || down the valleys fweep.

Where we find the cefure at the end of the fecond foot of the firft line, and in the middle of the third foot of the laft.

> Hang o'er their courfers heads || with eager fpeed,
> And earth rolls back || beneath the flying fteed.

Here the cefure is at the end of the third foot in the former, and of the fecond in the latter line.——The perception of this fpecies of harmony is far fuperior to the former; becaufe, to the pleafure of comparing the members of the fame line with each other, there is fuperadded that of comparing the different members of the different lines with each other; and the harmony is enriched by having four members of comparifon inftead of two. The pleafure is ftill increafed in comparing a greater number of lines, and obferving the relative proportion of the couplets to each other in point of fimilarity and diverfity. As thus,

> Thy forefts, Windfor, || and thy green retreats,
> At once the monarch's || and the mufe's feats,
> Invite my lays. || Be prefent fylvan maids,
> Unlock your fprings || and open all your fhades.

Here we find that the cefure is in the middle of the verfe in each line of the firft couplet and at the end of the fecond foot in each line of the laft; which gives a fimilarity in each couplet diftinctly confidered, and a diverfity when the one is compared with the other, that has a very pleafing effect. Nor is the pleafure lefs where we find a diverfity in the lines of each couplet, and a fimilarity in comparing the couplets themfelves. As in thefe,

> Not half fo fwift || the trembling doves can fly,
> When the fierce eagle || cleaves the liquid fky;
> Not half fo fwiftly || the fierce eagle moves,
> When thro' the clouds || he drives the trembling doves.

There is another mode of dividing lines well fuited to the nature of the couplet, by introducing femipaufes, which with the cefure divide the line into four portions. By a femipaufe, we mean a fmall reft of the voice, during a portion of time equal to half of that taken up by the cefure; as will be perceived in the following fine couplet;

> Warms | in the fun || refrefhes | in the breeze,
> Glows | in the ftars || and bloffoms | in the trees.

That the harmony, and of courfe the pleafure, refulting from poetic numbers, is increafed as well by the femipaufe as by the cefure, is obvious to every ear; becaufe lines fo conftructed furnifh a greater number of members for comparifon; but it is of more importance to obferve, that by means of the femipaufes, lines which, feparately confidered, are not of the fineft harmony, may yet produce it when oppofed to each other, and compared in the couplet. Of the truth of this obfervation, the following couplet, efpecially as it fucceeds that immediately quoted, is a ftriking proof:

> Lives | thro' all life || extends | thro' all extent,
> Spreads | undivided || operates | unfpent.

What we have advanced upon this fpecies of verfe, will contribute to folve a poetical problem thrown out by Dryden as a crux to his brethren: it was to account for the peculiar beauty of that celebrated couplet in Sir John Denham's *Cooper's Hill*, where he thus defcribes the Thames;

Versification.

Tho' deep | yet clear || tho' gentle | yet not dull.
Strong | without rage || without o'erflowing | full.

This description has great merit independent of the harmony of the numbers; but the chief beauty of the versification lies in the happy disposition of the pauses and semipauses, so as to make a fine harmony in each line when its portions are compared, and in the couplet when one line is compared with the other.

Having now said all that is necessary upon pauses and semipauses, we have done the utmost justice to our subject which the limits assigned us will permit. *Feet* and *pauses* are the constituent parts of verse; and the proper adjustment of them depends upon the poet's knowledge of *numbers*, *accent*, *quantity*, and *movement*, all of which we have endeavoured briefly to explain. In conformity to the practice of some critics, we might have treated separately of rhime and of blank verse; but as the essentials of all heroic verses are the same, such a division of our subject would have thrown no light upon the art of English versification. It may be just worth while to observe, that the pause at the end of a couplet ought to coincide, if possible, with a slight pause in the sense, and that there is no necessity for this coincidence of pauses at the end of any particular blank verse. We might likewise compare our heroic line with the ancient hexameter, and endeavour to appretiate their respective merits; but there is not a reader capable of attending to such a comparison who will not judge for himself; and it may perhaps be questioned, whether there be two who will form precisely the same judgment. Mr Sheridan, and all the mere English critics, give a high degree of preference to our heroic, on account of the vast variety of feet which it admits; whilst the readers of Greek and Latin poetry prefer the hexameter, on account of its more musical notes and majestic length.

Pogge || Poictou.

POGGE, the CATAPHRACTUS COTTUS, in ichthyology. See COTTUS, n° 2.

POGGIUS BRACCIOLINUS, a man of great parts and learning, who contributed much to the revival of knowledge in Europe, was born at Terranuova, in the territories of Florence, in 1380. His first public employment was that of writer of the apostolic letters, which he held 10 years, and was then made apostolic secretary, in which capacity he officiated 40 years, under seven popes. In 1453, when he was 72 years of age, he accepted the employment of secretary to the republic of Florence, to which place he removed, and died in 1459. He visited several countries, and searched many monasteries, to recover ancient authors, numbers of which he brought to light: his own works consist of moral pieces, orations, letters, and A History of Florence from 1350 to 1455, which is the most considerable of them.

POGO, is a name by which the inhabitants of the Philippine islands distinguish their quail, which, though smaller than ours, is in every other respect very like it.

POICTIERS, an ancient, large, and considerable town of France, capital of Poictou. It was a bishop's see, and contained four abbeys, a mint, an university famous for law, 22 parishes, 9 convents for men, and 12 nunneries. There are here several Roman antiquities, and particularly an amphitheatre, but partly demolished, and hid by the houses. There is also a triumphal arch, which serves as a gate to the great street. It is not peopled in proportion to its extent. Near this place Edward the Black Prince gained a decisive victory over the French, taking King John and his son Philip prisoners, in 1356, whom he afterwards brought over into England. See FRANCE, n° 71, &c.—It is seated on a hill on the river Clain, 52 miles south-west of Tours, and 120 north by east of Bourdeaux. E. Long. 0. 25. N. Lat. 46. 35.

POICTOU, a province of France, bounded on the north by Bretagne, Anjou, and part of Touraine; on the east by Touraine, Berry, and Manche; on the south by Angoumois, Saintonge, and the territory of Aunis; and on the west by the sea of Gascony. It is divided into the Upper and Lower; and is fertile in corn and wine, and feeds a great number of cattle, particularly mules. It was in possession of the kings of England for a considerable time, till it was lost by the unfortunate Henry VI. Poictiers is the capital town.

Poictou, Poinciana.

Colic of POICTOU. See MEDICINE, n° 303.

POINCIANA, BARBADOES FLOWER-FENCE: A genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the 33d order, *Lomentaceæ*. The calyx is pentaphyllous; the petals five, the uppermost larger than the rest; the stamina long, and all fertile; the seed-vessel a legumen. There is only one species, viz. the pulcherrima, a native of both Indies. It rises with a straight stalk 10 or 12 feet high, which is covered with a grey bark, and is sometimes as thick as the small of a man's leg, dividing into several spreading branches at the top, which are armed at each joint with two short, crooked, strong spines, and garnished with decompound winged leaves, each leaf consisting of six or eight pair of simple winged leaves. They are of a light green colour, and when bruised emit a strong odour. The branches are terminated by loose spikes of flowers, which are sometimes formed into a kind of pyramid, and at others disposed more in the form of an umbel. The footstalk of each flower is near three inches long; the flower is composed of five petals, which are roundish at the top, but are contracted to narrow tails at the base. They spread open, and are beautifully variegated with a deep red or orange colour, yellow, and some spots of green; and emit a very agreeable odour. After the flower is past, the germen becomes a broad flat pod three inches long, divided into three or four cells by transverse partitions, each including one flattish irregular seed. The plant is propagated by seeds; but, being tender, is to be constantly kept in the bark-stove. It is very impatient of moisture in winter; and if the least damp seizes its top, it either kills the plant or destroys its head. With proper management it will grow taller here than in the places where it is native; but its stems will not be thicker than a man's finger. In Barbadoes it is planted in hedges to divide the lands, whence it has the

the name of *flower-fence*. In the West Indies, its leaves are made use of as a purge instead of senna; and in Jamaica it is called *sena*.

POINT, a term used in various arts.

POINT, in grammar, a character used to mark the divisions of discourse (See COMMA, COLON, &c.) A point proper is what we otherwise call a *full stop* or *period*. See PUNCTUATION.

POINT, in geometry, according to Euclid, is that which hath neither parts nor magnitude.

POINT, in music, a mark or note anciently used to distinguish the tones or sounds: hence we still call it *simple counter-point*, when a note of the lower part answers exactly to that of an upper; and *figurative counter-point*, when any note is syncopated, and one of the parts makes several notes or inflexions of the voice, while the other holds on one.

We still use a point, to raise the value of a note, and prolong its time by one half, *e. g.* a point added to a semibreve instead of two minims, make it equal to three; and so of the other notes. See the article TIME.

POINT, in astronomy, a term applied to certain points or places marked in the heavens, and distinguished by proper epithets.

The four grand points or divisions of the horizon, viz. the east, west, north, and south, are called the *cardinal points*.

The zenith and nadir are the vertical points; the points wherein the orbits of the planets cut the plane of the ecliptic are called the *nodes*: the points wherein the equator and ecliptic intersect are called the *equinoctial points*; particularly, that whence the sun ascends towards the north pole, is called the *vernal point*; and that by which he descends to the south pole, the *autumnal point*. The points of the ecliptic, where the sun's ascent above the equator, and descent below it, terminate, are called the *solstitial point*; particularly the former of them, the *estival* or *summer-point*; the latter, the *brumal* or *winter-point*.

POINT is also used for a cape or headland jutting out into the sea: thus seamen say, two points of land are in one another, when they are so in a right line against each other, as that the innermost is hindered from being seen by the outermost.

POINT, in perspective, is used for various poles or places, with regard to the perspective plane. See PERSPECTIVE.

POINT is also an iron or steel instrument, used with some variety in several arts. Engravers, etchers, cutters in wood, &c. use points to trace their designs on the copper, wood, stone, &c. See the articles ENGRAVING, &c.

POINT, in the manufactories, is a general term, used for all kinds of laces wrought with the needle; such are the point le Venice, point de France, point de Genoa, &c. which are distinguished by the particular economy and arrangement of their points.—*Point* is sometimes used for lace woven with bobbins; as English point, point de Malines, point d'Havre, &c.

POINT, in poetry, denotes a lively brisk turn or conceit, usually found or expected at the close of an epigram. See POETRY, n° 169.

POINT-Blank, in gunnery, denotes the shot of a gun levelled horizontally, without either mounting or sinking the muzzle of the piece.—In shooting point-blank, the shot or bullet is supposed to go directly forward in a straight line to the mark; and not to move in a curve, as bombs and highly elevated random-shots do.—When a piece stands upon a level plane, and is laid level, the distance between the piece and the point where the shot touches the ground first, is called the *point-blank* range of that piece; but as the same piece ranges more or less, according to a greater or less charge, the point-blank range is taken from that of a piece loaded with such a charge as is used commonly in action. It is therefore necessary that these ranges of all pieces should be known, since the gunner judges from thence what elevation he is to give to his pieces when he is either farther from or nearer to the object to be fired at; and this he can do pretty nearly by sight, after considerable practice.

POINTING, in grammar, the art of dividing a discourse, by points, into periods and members of periods, in order to show the proper pauses to be made in reading, and to facilitate the pronunciation and understanding thereof. See the article PUNCTUATION.

POINTS, in heraldry, are the several different parts of an escutcheon, denoting the local positions of any figure. See HERALDRY, p. 441. col. 2.

POINTS, in electricity, are those acute terminations of bodies which facilitate the passage of the electrical fluid from or to such bodies. See ELECTRICITY.

POINTS, or *Vowel Points*, in the Hebrew language. See PHILOLOGY, Sect. I. n° 31, &c.

POISON, is any substance which proves destructive to the life of animals in a small quantity, either taken by the mouth, mixed with the blood, or applied to the nerves. See MEDICINE, n° 261, 269, 303, 322, 408, &c. &c.

Of poisons there are many different kinds, which are exceedingly various in their operations. The mineral poisons, as arsenic and corrosive mercury, seem to attack the solid parts of the stomach, and to produce death by eroding its substance: the antimonials seem rather to attack the nerves, and to kill by throwing the whole system into convulsions; and in this manner also most of the vegetable poisons seem to operate. All of these, however, seem to be inferior in strength to the poisons of some of the more deadly kinds of serpents, which operate so suddenly that the animal bit by them will be dead before another that had swallowed arsenic would be affected.

Much has been written concerning a poison made use of by the African negroes, by the Americans, and by the East Indians. To this very strange effects have been ascribed. It has been said that by this poison a man might be killed at any certain time; as, for instance, after the interval of a day, a week, a month, a year, or even several years. These wonderful effects, however, do not seem worthy of credit; as the Abbé Fontana has given a particular account of an American poison called *ticunas*, which in all probability is the same with that used in Africa and the East Indies; and from his account it is extremely improbable that any such effects could be produced with certainty.

With this poison the Abbé was furnished by Dr Heberden. It was closed and sealed up in an earthen pot inclosed in a tin-case. Within the tin-case was a note containing the following words: "Indian poison, brought from the banks of the river of the Amazons by

by Don Pedro Maldonado. It is one of the ſorts mentioned in the Philoſophical Tranſactions, Vol. XLVII. N° 12." In the volume of the Philoſophical Tranſactions here quoted, mention is made of two poiſons little different in their activity; the one called the *poiſon of Lamas*, and the other of *Ticunas*. The poiſon in the earthen veſſel uſed by the Abbé Fontana was that of the ticunas; he was alſo furniſhed with a number of American arrows dipped in poiſon, but whether that of the lamas or ticunas he could not tell.

Our author begins his account of the nature of this poiſon with detecting ſome of the miſtakes which had been propagated concerning it.—It had been aſſerted, that the Ticunas poiſon proves noxious by the mere effluvia, but much more by the ſteam which exhales from it in boiling or burning: that, among the Indians, it is prepared only by women condemned to die; and that the mark of its being ſufficiently prepared is when the attendant is killed by its ſteam. All theſe aſſertions are by the Abbé refuted in the cleareſt manner. He expoſed a young pigeon to the ſmell of the poiſon when the veſſel was opened, to the ſteam of it when boiling, and to the vapour of it when burning to the ſides of the veſſel, without the animal's being the leaſt injured; on which, concluding that the vapours of this poiſon were not to be dreaded, he expoſed himſelf to them without any fear.

This poiſon diſſolves very readily even in cold water, and likewiſe in the vegetable and mineral acids. With oil of vitriol it becomes as black as ink, but not with the reſt of the acids. In oil of vitriol it alſo diſſolves more ſlowly than in any of the reſt. It does not effervefce with acids or alkalis; neither does it alter milk, nor tinge it, except with the natural colour of the poiſon; nor does it tinge the vegetable juices either red or green. When examined by the microſcope, there is no appearance of regularity or cryſtallization; but it for the moſt part appears made up of very ſmall, irregular, roundiſh bodies, like vegetable juices. It dries without making any noiſe, and has an extremely bitter taſte when put upon the tongue.

The ticunas poiſon is harmleſs when put into the eyes; nor is it fatal when taken by the mouth, unleſs the quantity is conſiderable. Six grains of the ſolid poiſon, diſſolved in water, killed a young pigeon which drank it in leſs than 20 minutes. Five grains killed a ſmall Guinea-pig in 25 minutes. Eight grains killed a rabbit in an hour and eight minutes, &c. In thoſe experiments it was obſerved that much leſs poiſon was required to kill an animal whoſe ſtomach was empty than one that had a full ſtomach. Three rabbits and two pigeons were killed in leſs than 35 minutes by taking a doſe of three grains each on an empty ſtomach; but when the experiment was repeated on five animals with full ſtomachs, only one of them died.

The moſt fatal operation of this poiſon is when mixed with the blood. The ſmalleſt quantity, injected into the jugular vein, killed the animal as if by a ſtroke of lightning. When applied to wounds in ſuch a manner that the flowing of the blood could not waſh it away, the animal fell into convulſions and a train of fatal nervous ſymptoms, which put an end to its life in a few minutes. Yet, notwithſtanding theſe ſeeming affections of the nerves, the poiſon proved harmleſs when applied to the naked nerves themſelves, or even to the medullary ſubſtance of them ſlit open.

The ſtrength of this poiſon ſeems to be diminiſhed, and even deſtroyed, by mineral acids, but not at all by alkalis or ardent ſpirits; but if the freſh poiſon was applied to a wound, the application of mineral acids immediately after could not remove the pernicious effects. So far, indeed, was this from being the caſe, that the application of nitrous acid to the wounded muſcle of a pigeon killed the animal in a ſhort time without any poiſon at all.—The effects of the arrows were equally fatal with thoſe of the poiſon itſelf (A).

The poiſon of the viper is analogous in its effects to that of ticunas, but inferior in ſtrength; the latter killing more inſtantaneouſly when injected into a vein than even the poiſon of the moſt venemous rattleſnake.

The Abbé has, however, obſerved a difference in the action of the two poiſons upon blood taken out of the body. He cut off the head of a pigeon, and received its blood into two warm conical glaſſes, to the amount of about 80 drops into each. Into the blood contained in one porringer, he put four drops of water; and into the other four drops of the poiſon diſſolved in water as uſual. The event of this experiment was, that the blood, with which the water only was mixed, coagulated in a ſhort time; but that in which the poiſon was mixed did not coagulate at all. The poiſon of the viper alſo hinders the blood from coagulating, but gives it a much blacker tinge than the poiſon of the ticunas. The poiſon of the viper alſo proves certainly fatal when injected

(A) Mr Paterſon, *in his travels in Africa, in the years* 1777-8-9, fell in with an European woman who had been wounded with a poiſoned arrow. Great pains had been taken to cure her, but in vain; for at different periods of the year an inflammation came on which was ſucceeded by a partial mortification. She told him that the wound was eaſily healed up; but in two months afterwards there was a certainty of its breaking out again, and this had been the caſe for many years. The Hottentots poiſon their arrows with a ſpecies of euphorbia. See Euphorbia.—The amaryllis diſticha, a large bulbous plant growing about the Cape of Good Hope, called *mad poiſon*, is uſed for the ſame purpoſe. The natives take the bulbs when they are putting out their leaves, cut them tranſverſely, extract a thick fluid, and keep it in the ſun till it acquires the conſiſtence of gum, when it is fit for uſe. With arrows poiſoned with this gum they kill antelopes and other ſmall animals intended for food. After they are wounded, the animals generally run for ſeveral miles, and are frequently not found till next day. When the leaves of this plant are young, the cattle are very fond of them, though they occaſion inſtant death. Mr Paterſon mentions another ſhrubby plant producing a nut, called by the Dutch *woolf gift* or *wolf poiſon*, the only poiſon uſeful to the European inhabitants. The nuts are roaſted like coffee, pulverized, and ſtuffed into ſome pieces of meat or a dead dog, which are thrown into the fields. By this means the voracious hyenas are generally killed. See Rhus.

Poison. injected into the veins, even in very ſmall quantity; but it produces a kind of grumous coagulation and blackneſs in the blood when drawn from a vein, though it prevents the proper coagulation of that fluid, and its ſeparation into craſſamentum and ſerum as uſual. See Viper.

In the Philoſophical Tranſactions, N° 335. we have a number of experiments which ſhow the effects of many different poiſons upon animals; from whence it appears, that many ſubſtances which are not at all accounted poiſonous, yet prove as certainly fatal when mixed with the blood as even the poiſon of rattleſnakes, or the ticunas itſelf.—An ounce of emetic wine, being injected into the jugular vein of a large dog, produced no effect for a quarter of an hour. At the expiration of that ſpace he became ſick, had a continual vomiting, and evacuation of ſome hard excrements by ſtool. By theſe evacuations he ſeemed to be ſomewhat relieved; but ſoon grew uneaſy, moved from place to place, and vomited again. After this he laid himſelf down on the ground pretty quietly; but his reſt was diſturbed by a return of his vomiting, and his ſtrength greatly decreaſed. An hour and an half after the operation he appeared half dead, but was greatly revived by having ſome warm broth poured down his throat with a funnel. This, however, proved only a temporary relief; for in a ſhort time the vomiting returned, he made urine in great quantity, howled miſerably, and died in convulſions.—A dram and an half of ſal ammoniac diſſolved in an ounce and an half of water, and injected into the jugular vein of a dog, killed him with convulſions almoſt inſtantly.—The ſame effect followed from injecting a dram of ſalt of tartar diſſolved in an ounce of warm water; but a dram and an half of common ſalt injected into the jugular produced little other bad conſequence than a temporary thirſt.—A dram of purified white vitriol, injected into the crural vein of a dog, killed him immediately.—Fifteen grains of ſalt of urine diſſolved in an ounce of water, and injected into the crural vein of a dog, threw him into ſuch violent convulſions that he ſeemed to be dying; nevertheleſs he recovered from a ſecond doſe, though not without a great deal of difficulty: but an ounce of urine made by a man faſting produced no bad effect. Diluted aquafortis injected into the jugular and crural vein of a dog killed him immediately by coagulating the blood. Oil of ſulphur (containing ſome quantity of the volatile vitriolic acid) did not kill a dog after repeated trials. On the contrary, as ſoon as he was let go, he ran into all the corners of the room ſearching for meat: and having found ſome bones, he fell a gnawing them with ſtrange avidity, as if the acid, by injection into his veins, had given him a better appetite.—Another dog who had oil of tartar injected into his veins, ſwelled and died, after ſuffering great torment. His blood was found florid, and not coagulated.—A dram and a half of ſpirit of ſalt diluted with water, and injected into the jugular vein of a dog, killed him immediately. In the right ventricle of the heart the blood was found partly grumous and concreted into harder clots than ordinary, and partly frothy. Warm vinegar was injected without doing any manifeſt harm.—Two drams of ſugar diſſolved into an ounce of water were injected into the jugular vein of a dog without any hurt.

Theſe are the reſults of the experiments where ſaline ſubſtances were injected into the veins. Many acrids proved equally fatal. A decoction of two drams of white hellebore, injected into the jugular vein of a dog, killed him like a ſtroke of lightning. Another dog was killed in a moment by an injection of an ounce of rectified ſpirit of wine in which a dram of camphor was diſſolved.—Ten drams of highly rectified ſpirit of wine, injected into the crural vein of a dog, killed him in a very ſhort time: he died quietly, and licking his jaws with his tongue, as if with pleaſure. In the vena cava and right ventricle of the heart the blood was coagulated into a great many little clots.—Three drams of rectified ſpirit of wine injected into the crural vein of a ſmall dog made him apoplectic, and as it were half dead. In a little time he recovered from the apoplexy, and became giddy; and, when he endeavoured to go, reeled and fell down. Though his ſtrength increaſed by degrees, yet his drunkenneſs continued. His eyes were red and fiery; and his ſight ſo dull that he ſcarce ſeemed to take notice of any thing: and when he was beat, he would ſcarce move. However, in four hours he began to recover, and would eat bread when offered him; the next day he was out of danger.—Five ounces of ſtrong white-wine injected into the crural vein of a dog made him very drunk for a few hours, but did not produce any other conſequences. An ounce of ſtrong decoction of tobacco injected into a vein killed a dog in a very ſhort time in terrible convulſions. Ten drops of oil of ſage rubbed with half a dram of ſugar, and thus diſſolved in water, did no harm by being injected into the blood.

Mercury, though ſeemingly void of all acrimony, proves alſo fatal when injected into the blood. Soon after the injection of half an ounce of this mineral into the jugular vein of a dog, he was ſeized with a dry ſhort cough which came by intervals. About two days after, he was troubled with a great difficulty of breathing, and made a noiſe like that of a broken-winded horſe. There was no tumour about the root of the tongue or the parotid glands, nor any appearance of a ſalivation. In four days he died; having been for two days before ſo much troubled with an orthopnœa, that he could ſleep only when he leaned his head againſt ſomething. When opened, about a pint of bloody ſerum was found in the thorax, and the outſide of the lungs in moſt places was bliſtered. Some of the bliſters were larger and others ſmaller than a pea, but moſt of them contained mercurial globules. Several of them were broken; and upon being preſſed a little, the mercury ran out with a mixture of a little ſanies; but upon ſtronger preſſure, a conſiderable quantity of ſanies iſſued out. In the right ventricle of the heart ſome particles of quickſilver were found in the very middle of the coagulated blood lodged there, and the ſame thing alſo was obſerved in the pulmonary artery. Some blood alſo was found coagulated in a very ſtrange and unuſual manner between the columnæ of the right ventricle of the the heart, and in this a greater quantity of quickſilver than anywhere elſe. In the left ventricle was found a very tenacious blood, coagulated, and ſticking to the great valve, including the tendons of it, and a little reſembling a polypus. No mercury could be found in this ventricle by the moſt diligent ſearch; whence it appears, that the mercury had paſſed no farther than the extremities of the pulmonary artery, where it had ſtuck, and occaſioned fatal obſtructions.—In another dog, which had mercury injected into

into the jugular, it appears to have paſſed the pulmonary artery, as part of it was found in the cavity of the abdomen, and part alſo in ſome other cavities of the body. All the glandules were very turgid and full of liquor, eſpecially in the ventricles of the brain, and all round there was a great quantity of ſerum.

In like manner, oil of olives proves certainly fatal when injected into the blood. Half an ounce of this, injected into the crural vein of a dog, produced no effect in half a quarter of an hour: but after that, the animal barked, cried, looked dejected, and fell into a deep apoplexy; ſo that his limbs were deprived of all ſenſe and motion, and were flexible any way at pleaſure. His reſpiration continued very ſtrong, with a ſnorting and wheezing, and a thick humour ſometimes mixed with blood flowing out of his mouth. He loſt all external ſenſe: the eyes, though they continued open, were not ſenſible of any objects that were put to them; and even the cornea could be touched and rubbed, without his being the leaſt ſenſible of it: his eyelids, however, had a convulſive motion. The hearing was quite loſt; and in a ſhort time the feeling became ſo dull, that his claws and ears could be bored with red-hot pincers without his expreſſing the leaſt ſenſe of pain. Sometimes he was ſeized with a convulſive motion of the diaphragm and muſcles ſubſervient to reſpiration; upon which he would bark ſtrongly, as if he had been awake: but this waking was only in appearance; for all the time of this barking he continued as inſenſible as ever. In three hours he died; and on opening his body, the bronchiæ were filled with a thick froth.—An ounce of oil of olives injected into the jugular of another dog killed him in a moment; but a third lived an hour after it. He was ſeized with great ſleepineſs, ſnorting, and wheezing, but did not bark like the firſt. In all of them a great quantity of thick froth was found in the lungs.

We come now to ſpeak of thoſe poiſons which prove mortal (B) when taken by the mouth. The principal of theſe are, arſenic, corroſive mercury, glaſs of antimony, and lead *. What the effects of theſe ſubſtances are when injected into the blood, cannot be related, as no experiments ſeem to have been made with them in that way, excepting antimony, whoſe effects have been already mentioned. The effects of opium, when injected into the veins, ſeem to be ſimilar to its effects when taken by the mouth. Fifty grains of opium, diſſolved in an ounce of water, were injected into the crural vein of a cat. Immediately after the operation ſhe ſeemed much dejected, but did not cry; only made a low, interrupted, and complaining noiſe. This was ſucceeded by trembling of the limbs, convulſive motions of the eyes, ears, lips, and almoſt all parts of the body, with violent convulſions of the breaſt. Sometimes ſhe would raiſe up her head, and ſeem to look about her; but her eyes were very dull, and looked dead. Though ſhe was let looſe, and had nothing tied about her neck, yet her mouth was ſo filled with froth, that ſhe was almoſt ſtrangled. At laſt, her convulſive motions continuing, and being ſeized with ſtretching of her limbs, ſhe died in a quarter of an hour. Upon opening the body, the blood was found not to be much altered from its natural ſtate.—A dram and an half of opium was diſſolved in an ounce and an half of water, and then injected into the crural vein of a luſty ſtrong dog. He ſtruggled violently; made a loud noiſe, though his jaws were tied; had a great difficulty of breathing, and palpitation of the heart; with convulſive motions of almoſt all parts of his body. Theſe ſymptoms were ſucceeded by a profound and apoplectic ſleep. Having untied him, he lay upon the ground without moving or making any noiſe, though ſeverely beaten. About half an hour after he began to recover ſome ſenſe, and would move a little when beaten. The ſleepineſs ſtill decreaſed; ſo that in an hour and a half he would make a noiſe and walk a little when beat. However, he died in four days, after having voided a quantity of fetid excrements, in colour reſembling the diluted opium he had ſwallowed.

* See *Chemiſtry*, n° 925, 1256, &c. *Medicine* as above referred to, and *Pharmacy*, *paſſim.*

The oil of tobacco has generally been reckoned a very violent poiſon when introduced into the blood; but from the Abbé Fontana's experiments, it appears to be far inferior in ſtrength to the poiſon of ticunas, or to the bite of a viper. A drop of oil of tobacco was put into a ſmall inciſion in the right thigh of a pigeon, and in two minutes the animal could not ſtand on its right foot. The ſame experiment was repeated on another pigeon and produced exactly the ſame effect. In another caſe, the oil was applied to a ſlight wound in the breaſt; three minutes after which, the animal could not ſtand on the left foot. This experiment was alſo repeated a ſecond time, with the ſame ſucceſs. A tooth-pick, ſteeped in oil of tobacco, and introduced into the muſcles of the breaſt, made the animal fall down in a few ſeconds as if dead. Applied to two others, they threw up ſeveral times all the food they had eaten. Two others treated in the ſame manner, but with empty ſtomachs, made many efforts to vomit.—In general, the vomiting was found to be a conſtant effect of this poiſon: but the loſs of motion in the part to which the poiſon is applied, was found to be only accidental. None of the animals died by the application

(B) Of all poiſons * thoſe which may be called culinary are perhaps the moſt deſtructive, becauſe they are generally the leaſt ſuſpected. All copper ‡ veſſels, therefore, and veſſels of bell-metal, which contains copper, ſhould be laid aſide. Even the common *earthen-ware*, when they contain acids, as in pickling, become very pernicious, as they are glazed with lead, which in the ſmalleſt quantity when diſſolved is very fatal; and even tin, the leaſt exceptionable of the metals for culinary purpoſes except iron, is not always quite free of poiſonous qualities, it having been found to contain a ſmall portion of arſenic. Muſhrooms and the common laurel are alſo very fatal. The bitter almond contains a poiſon, and its antidote likewiſe. The cordial dram *ratafia*, much uſed in France, is a ſlow poiſon, its flavour being procured from the kernels of peach, black cherry ſtones, &c.—The ſpirit of *lauro-ceraſus* is peculiarly fatal. The adulteration of bread, beer, wine, porter, &c. produces very fatal conſequences, and merits exemplary puniſhment. Next to culinary poiſons the abuſe of medicines deſerves particular attention.

* See *Leake's Practical Treatiſe on Diſeaſes of the Viſcera.*

‡ See *P*[...] *ſon of C*[...] *per.*

application of oil of tobacco. Dr Leake however afferts the contrary; faying, that this oil, which is ufed by the Indians in poifoning arrows, when infufed into a frefh wound, befides ficknefs and vomiting, occafions convulfions and death. See *Practical Effay on Difeafes of the Vifcera*, p. 67.

The pernicious effects of laurel-water are taken notice of under the article MEDICINE, n° 261. The account is confirmed by the experiments of the Abbé Fontana; who tells us, that it not only kills in a fhort time when taken by the mouth, but that, when given in fmall dofes, the animal writhes fo that the head joins the tail, and the vertebræ arch out in fuch a manner as to ftrike with horror every one who fees it. In order to afcertain the effects of this water when taken into the blood, our author opened the fkin of the lower belly of a pretty large rabbit, and made a wound in it about an inch long; and having flightly wounded the mufcles under it in many parts, applied two or three tea-fpoonfuls of laurel-water. The animal fell down convulfed in lefs than three minutes, and died foon after. The experiment was repeated with fimilar fuccefs in other animals; but was always found to act moft powerfully, and in the fhorteft time, when taken by the mouth, or injected by way of clyfter. From thefe experiments, however, he concluded, that laurel-water would kill by being injected into the blood: but in this he was deceived; for two rabbits had each of them a large tea-fpoonful injected into the jugular vein, without any inconvenience either at the time of injection or afterwards. It proved innocent alfo when applied to the bare nerves, and even when introduced into their medullary fubftance.

We ought now to give fome account of the proper antidotes for each kind of poifon; but from what has been related concerning the extreme activity of fome of them, it is evident that in many cafes there can be but very little hope. People are moft apt to be bit by ferpents in the legs or hands; and as the poifon, from the Abbé Fontana's experiments, appears to act only in confequence of being abforbed into the blood, it is plain, that to prevent this abforption is the chief indication of cure. We have recommended feveral methods for this purpofe under the article MEDICINE, n° 408.; but the Abbé Fontana propofes another not mentioned there, namely, ligature. This, if properly applied between the wounded part and the heart, muft certainly prevent the bad effects of the poifon: but then it tends to produce a difeafe almoft equally fatal; namely, a gangrene of the part; and our author gives inftances of animals being thus deftroyed after the effects of the poifon were prevented; for which reafon he prefers amputation. But the good effects of either of thefe methods, it is evident, muft depend greatly on the nature of the part wounded, and the time when the ligature is applied or the amputation performed. If the teeth of the ferpent, or the poifoned arrow, happens to ftrike a large vein, the only poffibility of efcaping inftant death is to comprefs the trunk of the vein above the wounded place, and to enlarge the wound, that the blood may flow freely and in large quantity, in order to wafh away the poifon, and difcharge the infected parts of the blood itfelf. If this is neglected, and the perfon falls into the agonies of death, perhaps ftrongly ftimulating medicines given in large dofes, and continued for a length of time, may enable nature to counteract the virulence of the poifon. For this purpofe volatile alkalis feem moft proper, as acting fooneft. See MEDICINE, p. 346. col. 2. and p. 347. col. 1.; and perhaps a combination of them with ether might be advantageous, as by the volatility of that medicine the activity of the alkali would probably be increafed. In the Philofophical Tranfactions, we have an account of the recovery of a dog feemingly by means of the volatile alkali, when probably he was in a dying condition. This dog indeed feems to have had a remarkable ftrength of conftitution. The poor creature had firft got two ounces of the juice of nightfhade, which he bore without any inconvenience. An equal quantity of the juice of hemlock was then given him without effect. He then got a large dofe of the root of wolfsbane with the fame fuccefs. Two drachms of white hellebore root were next given. Thefe caufed violent vomitings and purgings, but ftill he outlived the operation. He was then made to fwallow five roots of the colchicum, or meadow-faffron, dug frefh out of the earth. The effect of thefe was fimilar to that of the white hellebore, but ftill he did not die. Laftly, he got two drams of opium; and he even outlived this dofe. He was firft caft into a deep fleep by it; but foon awaked, and was feized with violent vomitings and purgings, which carried off the effect of the opium. Seeing then that the animal had refifted the moft violent poifons, it was refolved to try the effects of the bite of a viper; and he was accordingly bit three or four times on the belly a little below the navel by one enraged. The immediate confequence of this was an incipient gangrene in the parts adjoining to the wound, as appeared by the rifing of little black bladders filled with a fanious matter, and a livid colour which propagated itfelf all around. The motion of the heart became very faint and irregular, and the animal lay without ftrength or fenfation, as if he had been feized with a lethargy or apoplexy. In this condition his wound was cupped and fcarified, and Venice treacle (a famous antidote) applied to it. In two hours after this all the fymptoms were increafed, and he feemed to be nearly dead; upon which half a drachm of volatile falt of hartfhorn mixed with a little broth was poured down his throat; and the confequence was, that in a fhort time he was able to ftand on his feet and walk. Another dofe entirely difpelled his lethargy, and the heart began to recover its ftrength. However, he continued very weak; and though he eat no folid meat for three days, yet at the end of that time his ftrength was evidently increafed. The firft day he drank water plentifully and greedily, and on the fecond day he drank fome broth. On the third day he began to eat folid meat, and feemed out of danger; only fome large and foul ulcers remained on that part of the belly which was bit, and before thefe were healed he was killed by another dog.

From comparing this with fome other obfervations, indeed, it would feem that volatile alkali is the beft antidote againft all poifons which fuddenly kill by a mixture with the blood, and even of fome others. Indeed its effects in curing the bite of fnakes feems to be put beyond all doubt, by a paper in the 2d volume of the Afiatic Refearches, p. 323. "From the effect of a ligature applied between the bitten part and the heart (fays Mr Williams, the author of the paper), it is evident that

that the poifon diffufes itfelf over the body by the returning venous blood; deftroying the irritability, and rendering the fyftem paralytic. It is therefore probable, that the volatile cauftic alkali, in refifting the difeafe of the poifon, does not act fo much as a fpecific in deftroying its quality, as by counteracting the effect on the fyftem, by ftimulating the fibres, and preferving that irritability which it tends to deftroy."

But whatever be the mode of its operation, the medicine is unqueftionably powerful. Mr Williams ufed either the volatile cauftic alkali, or eau-de-luce; the former of which he feems to have preferred. Of it he gave 60 drops as a dofe in water, and of the eau-de-luce he gave 40, at the fame time applying fome of the medicine to the part bitten, and repeating the dofe as he found occafion. Of feven cafes, fome of which were apparently very defperate, only one died, and that appears to have been occafioned by bad treatment after the cure. Many of the patients were perfectly recovered in feven or eight minutes, and none of them required more than two hours: On the whole, Mr Williams fays that he "never knew an inftance of the volatile cauftic alkali failing in its effect, where the patient has been able to fwallow it." Dr Mead afferts, that the alkali counteracts the deadly effects of laurel water; we have feen its effects in curing the bite of a viper, and of fnakes; and from Dr Wolfe's experiments on hydrophobous patients, it may even claim fome merit there. Still, however, there is another method of attempting a cure in fuch deplorable cafes; and that is, by injecting into the veins any thing which will not deftroy life, but will deftroy the effects of the poifon. It is much to be regretted, that in thofe cruel experiments which we have already related, the intention feems almoft always to have been to kill the animal at all events; whereas, it ought to have been to preferve him alive, and to afcertain what medicines could be fafely injected into the blood, and what could not, with the effects which followed the injection of different quantities, none of which were fufficient to deftroy life. But in the way they were managed, fcarce any conclufion can be drawn from them. Indeed it appears that little good is to be expected from this mode; it is mere fpeculation, and future experiments muft fhow whether it ever fhall be ufed for the cure of poifons, or for any other purpofes: its being now totally laid afide, feems to militate ftrongly againft the efficacy of it; befides, the extreme cruelty of the operation will ever be a ftrong bar to its general introduction. See INJECTION.

There ftill remains another method of cure in defperate cafes, when there is a certainty that the whole mafs of blood is infected; and that is, by the bold attempt of changing the whole difeafed fluid for the blood of a found animal. Experiments of this kind have alfo been tried; and the method of making them, together with the confequences of fuch as are recorded in the Philofophical Tranfactions, we fhall notice under the article TRANSFUSION.

Dr Mead, finding that many pretenders to philofophy have called the goodnefs of the Creator in queftion, for having created fubftances whofe manifeft and obvious qualities are noxious and deftructive, remarks, by way of anfwer, that they have alfo falutary virtues. But, befides their phyfical effects, they are likewife food for animals which afford us good nourifhment, goats and quails being fattened by hellebore, ftarlings by hemlock, and hogs innocently eating henbane; befides, fome of thofe vegetables, which were formerly thought poifonous, are now ufed in medicine, and future difcoveries may probably increafe the number. The poifon of many vegetables is their only defence againft the ravages of animals; and by means of them we are often enabled to defend ufeful plants from the deftroying infect; fuch as by fprinkling them with effential oil of turpentine; and by means of fome fubftances poifonous to them, we are enabled to deftroy thofe infects which infeft the human body, and the bodies of domeftic animals, &c.—As for poifonous minerals, arfenic for example, Dr Mead obferves, that it is not a perfect mineral, but only an active fubftance, made ufe of by nature in preparing feveral metals in the earth, which are of great fervice to mankind; and, after confirming this by feveral inftances, he concludes by faying, the cafe will be found much the fame in all natural productions of this kind. As for poifonous animals, &c. their noxious qualities may eafily be accounted for, by reflecting that it is their only mode of felf-defence. See ARANEA, p. 195. and SERPENT.

POISON of Copper. This metal, though when in an undiffolved ftate it produces no fenfible effects, becomes exceedingly active when diffolved; and fuch is the facility with which the folution is effected, that it becomes a matter of fome confequence to prevent the metal from being taken into the human body even in its proper form. It doth not, however, appear that the poifon of copper is equally pernicious with thofe of arfenic or lead; much lefs with fome others treated of in the laft article. The reafon of this is, that it excites vomiting fo fpeedily as to be expelled, even though taken in confiderable quantity, before it has time to corrode the ftomach. Roman vitriol, which is a folution of copper in the vitriolic acid, has been ufed as a medicine in fome difeafes with great fuccefs. Verdigrife alfo, which is another very active preparation of the metal, has been by fome phyficians prefcribed as an emetic, efpecially in cafes where other poifons had been fwallowed, in order to procure the moft fpeedy evacuation of them by vomit. Where copper is not ufed with this view, it has been employed as a tonic and antifpafmodic, with which it has been admitted into the Edinburgh Difpenfatory under the title of *Cuprum Ammoniacale*. The effects of the metal, however, when taken in a pretty large quantity, and in a diffolved ftate, or when the ftomach abounds with acid juices fufficient to diffolve it, are very difagreeable and even dangerous; as it occafions violent vomitings, pains in the ftomach, faintings, and fometimes convulfions and death. The only cure for thefe fymptoms is to expel the poifon by vomiting as foon as poffible, and to obtund its acrimony; for which purpofe drinking warm milk will probably be found the moft efficacious remedy. In order to prevent the entrance of the poifon into the body, no copper veffels fhould be ufed in preparing food but fuch as are either well tinned or kept exceedingly clean. The practice of giving a fine blue or green colour to pickles, by preparing them in copper veffels, ought not to be tolerated; for Dr Falconer, in a treatife on this fubject, affures us, that thefe are fometimes fo ftrongly impregnated by this method of

preparing

preparing them, that a fmall quantity of them will produce a flight naufea.——Mortars of brafs or bell-metal ought for the fame reafon to be avoided, as by this means a confiderable quantity of the pernicious metal may be mixed with our food, or with medicines. In other cafes, an equal caution ought to be ufed. The cuftom of keeping pins in the mouth, of giving copper halfpence to children to play with, &c. ought to be avoided; as thus a quantity of the metal may be infenfibly taken into the body, after which its effects muft be uncertain.——It is proper to obferve, however, that copper is much more eafily diffolved when cold than when hot; and therefore the greateft care fhould be taken never to let any thing defigned for food, even common water, remain long in copper veffels when cold; for it is obferved, that though the confectioners can fafely prepare the moft acid fyrups in clean copper veffels without their receiving any detriment whilft hot, yet if the fame fyrups are allowed to remain in the veffels till quite cold, they become impregnated with the pernicious qualities of the metal.

Poison of Lead. See Medicine, n° 303.

Poison-Tree. See Rhus.

Poison-Tree of Java, called in the Malayan language *bohun upas*, is a tree which has often been defcribed by naturalifts; but its exiftence has been very generally doubted, and the defcriptions given of it containing much of the marvellous, have been often treated as idle fictions. N. P. Foerfch, however, in an account of it written in Dutch, afferts that it does exift; and tells us, that he once doubted it as much as any perfon; but, determined not to truft general opinions, he made the moft particular inquiries poffible; the refult of which was, that he found that it is fituated in the ifland of Java, about 27 leagues from Batavia, 14 from Soura Charta, the emperor's feat, and about 19 from Tinkjoe, the refidence of the fultan of Java. It is furrounded on all fides by hills and mountains, and the adjacent country for 12 miles round the tree is totally barren. Our author fays he has gone all round the fpot at about 18 miles from the centre, and on all fides he found the country equally dreary, which he afcribes to its noxious effluvia. The poifon procured from it is a gum, iffuing from between the bark and the tree; and it is brought by malefactors who have been condemned to death, but who are allowed by this alternative to have a chance for their life. An old ecclefiaftic, our author informs us, dwelt on the outfide of the furrounding hills, whofe bufinefs it was to prepare the criminals for their fate, if death fhould be the confequence of their expedition. And indeed fo fatal is its effluvia, that he acknowledged that fcarcely two out of 20 returned from above 700 whom he had difmiffed.

Mr Foerfch farther tells us, that he had feen feveral of the criminals who had returned, and who told him, that the tree ftands on the borders of a rivulet, is of a middling fize, and that five or fix young ones of the fame kind ftand clofe to it. They could not, however, fee any other plant or fhrub near it; and the ground was of brownifh fand, full of ftones and dead bodies, and difficult to pafs. The Malayans think this tract was thus rendered noxious and uninhabitable by the judgement of God, at Mahomet's defire, on account of the fins of the inhabitants. No animal whatever is ever feen there; and fuch as get there by any means never return, but have been brought out dead by fuch of the criminals as have themfelves efcaped death.

Our author relates a circumftance which happened in the year 1775, to about 400 families (1600 fouls), who refufed to pay fome duty to the emperor, and who were in confequence declared rebels and banifhed: they petitioned for leave to fettle in the uncultivated parts round Upas: the confequence of which was, that in lefs than two months their number was reduced to about 300 fouls, who begged to be reconciled to the emperor, and were again received under his protection. Many of thefe furvivors Mr Foerfch faw, and they had juft the appearance of perfons tainted with an infectious diforder.

With the juice of this tree arrows, lancets, and other offenfive weapons, are poifoned. With lancets thus poifoned, Mr Foerfch obferves, that he faw 13 of the emperor's concubines executed for infidelity to his bed in February 1776. They were lanced in the middle of their breafts; in five minutes after which they were feized with a *tremor* and *fubfultus tendinum*, and in 15 minutes they were dead. Their bodies were full of livid fpots, like thofe of *petechiæ*, their faces fwelled, colour blue, and eyes yellow, &c. Soon after he faw feven Malayans executed in the fame way, and faw the fame effects follow; on which he refolved to try it on other animals, and found the operation fimilar on three puppies, a cat, and a fowl, none of which furvived more than 13 minutes. He alfo tried its effects internally on a dog feven months old; the animal became delirious, was feized with convulfions, and died in half an hour. From all which our author concludes, that it is the moft violent of all vegetable poifons, and that it contributes greatly to the unhealthinefs of the ifland in which it grows. By means of it many cruel and treacherous murders are perpetrated. He adds, that there exifts a fort of cajoe-upas on the coaft of Macaffar, the poifon of which, though not near fo violent or malignant, operates nearly in the fame manner.

To this account our readers will give fuch a degree of credit as they think is due; it is our bufinefs however to add, that it has been controverted in all its parts in a memoir of Lambert Nolft, M. D. fellow of the Batavian Experimental Society at Rotterdam, (fee Gentleman's Mag. May 1794, p. 433.) This memoir was procured from John Matthew a Rhyn, who had been 23 years, from 1763 to 1786, refident in the ifland, and therefore had every opportunity of informing himfelf on the fpot. In this memoir we are told, that Foerfch's account of the tree is extremely fufpicious, from a variety of circumftances: 1. Though he had letters of introduction, he went to no confiderable houfe, and afterwards privately withdrew among the Englifh. 2. When the emperor was afked refpecting Foerfch, and the facts he relates, he anfwered, that he had never heard either of him or of the tree. 3. The diftances given to mark the fituation of the tree are not accurate. 4. The execution of criminals is different from what he reprefents. 5. The circumftance of feveral criminals returning when Foerfch was there has a fufpicious appearance. 6. There exifts no fuch tradition, as that the tree was placed there by Mahomet. 7. There were no fuch difturbances in 1775 as Foerfch reprefents, the tract to which

which he alludes having ſubmitted to the Dutch Eaſt India Company as early as 1756. 8. The iſland is not unhealthy, as Foerſch aſſerts; nor are violent or premature deaths frequent. 9. The Javaneſe are a curious and intelligent people, and of courſe could not be ſo ignorant of this tree if it had any exiſtence. 10. The aſſertions and pretended facts of Foerſch have no colateral evidence; and every thing which we gather from the accounts of others, or from the hiſtory of the people, invalidates them. For theſe and other reaſons, Dr Nolſt concludes, that very little credit is due to the repreſentations of Foerſch, and that the iſland of Java produces no ſuch tree, which, if it really grew there, would be the moſt remarkable of all trees.

POLA, in ichthyology, is the name of a flat fiſh, reſembling the ſoal, but ſomewhat ſhorter and ſmaller. It is called *cynogloſſus* and *linguatula*. It abounds in the Mediterranean, and is ſold both in Rome and in Venice for the table.

POLACRE, a ſhip with three maſts, uſually navigated in the Levant and other parts of the Mediterranean. Theſe veſſels are generally furniſhed with ſquare ſails upon the main-maſt, and *lateen* ſails upon the fore-maſt and mizen-maſt. Some of them, however, carry ſquare ſails upon all the three maſts, particularly thoſe of Provence in France. Each of their maſts is commonly formed of one piece, ſo that they have neither top-maſt nor top-gallant-maſt; neither have they any *horſes* to their yards, becauſe the men ſtand upon the top-ſail-yard to looſe or furl the top-gallant-ſail, and on the lower-yard to *reef*, to looſe, or furl, the top-ſail, whoſe yard is lowered ſufficiently down for that purpoſe.

POLAEDRASTYLA, in natural hiſtory, is the name of a genus of cryſtals, derived from the Greek πολυς, *many*, ἑδρα, *ſides*, the primitive particle α, *not*, and στυλος, a column; and means a cryſtal with many planes, and without a column.

The bodies of this genus are cryſtals of two octangular pyramids, with the baſes joined, the whole body conſiſting of 16 planes. Of this genus there are only two ſpecies known: 1. A brown kind with ſhort pyramids, found in great plenty in Virginia on the ſides of hills; and, 2. A colourleſs one, with longer pyramids. This has yet been found only in one place, which is the great mine at Goſſalaer, in Saxony, where it uſually lies at great depths.

POLAND, a kingdom of Europe, in its largeſt extent bounded by Pomerania, Brandenburg, Sileſia, and Moravia, to the weſt; and, towards the eaſt, by part of Ruſſia and the Leſſer Tartary; on the north, it has the Baltic, Ruſſia, the grand province of Livonia, and Samogitia; and on the ſouth, it is bounded by Beſſarabia, Tranſylvania, Moldavia, and Hungary. Geographers generally divide it into the provinces of Poland Proper, Lithuania, Samogitia, Courland, Pruſſia, Maſſovia, Polachia, Poleſia, Little Ruſſia, called likewiſe *Ruſſia Rubra* or *Red Ruſſia*, Podolia, and the Ukrain. Now, however, it is very conſiderably reduced in extent, as will appear in the courſe of its hiſtory. For a map of Poland, Lithuania, and Pruſſia, ſee Plate CCCCX.

With regard to the hiſtory of Poland, we are not to gather the earlier part of it from any accounts tranſmitted to us by the natives. The early hiſtories of all nations indeed are involved in fable; but the Poles never had even a fabulous hiſtory of their own nation. The reaſon of this is, that it was not the cuſtom with that nation to entertain itinerant poets for the amuſement of the great; for to the ſongs of theſe poets entertained among other nations we are obliged for the early part of their hiſtory; but this aſſiſtance being deficient in Poland, we muſt have recourſe to what is recorded concerning it by the hiſtorians of other nations.

r Poliſh ſovereig firſt o ſtyled dukes.

The ſovereigns of Poland at firſt had the title of *duces*, dukes or generals, as if their office had been only to lead the armies into the field. The firſt of theſe is univerſally allowed to have been Lechus or Lecht; and to render him more illuſtrious, he is ſaid to have been a lineal deſcendant from Japhet the ſon of Noah. According to ſome writers, he migrated at the head of a numerous body of the deſcendants of the ancient Sclavi from ſome of the neighbouring nations; and, to this day, Poland is called by the Tartars the kingdom of *Lechus*. Buſching, however, gives a different account of the origin of the Poles. Sarmatia, he obſerves, was an extenſive country, inhabited by a variety of nations of different names. He ſuppoſes the Poles to be the deſcendants of the ancient Lazi, a people who lived in Colchis near the Pontus Euxinus; whence the Poles are ſometimes called *Polazi*. Croſſing ſeveral rivers, they entered Poſnania, and ſettled on the borders of the Warta, while their neighbours the Zechi ſettled on the Elbe, in the 550th year of Chriſt. As to the name of *Poland*, or *Polſka*, as it is called by the natives, it comes from the Sclavonic word *Pole*, or *Poln*, which ſignifies a country adapted to hunting, becauſe the whole country was formerly covered with vaſt foreſts, exceedingly proper for that employment.

s Lechu firſt d

3 Deriv of the rent n of Pol

4 Viſcim the ſe duke.

Of the tranſactions of Lechus during the time that he enjoyed the ſovereignty, we have no certain account. His ſucceſſor was named *Viſcimer*, who is generally ſuppoſed to have been the nephew of Lechus. He was a warlike and ſucceſsful prince, ſubduing many provinces of Denmark, and building the city of Wiſmar, ſo called from the name of the ſovereign. But the Daniſh hiſtorians take no notice of his wars with their country; nor do they even mention a prince of this name. However, he is ſaid to have reigned for a long time with great glory; but to have left the people in great diſtreſs, on account of the diſputes which aroſe about a ſucceſſor.

5 Form govern ment c ged in ariſtoc

After the death of Viſcimer, the nobility were on the point of electing a ſovereign, when the people, haraſſed by the grievous burdens occaſioned by the wars of Viſcimer, unanimouſly demanded another form of government, that they might no longer be liable to ſuffer from ambition and tyranny. At firſt the nobility pretended to yield to this humour of the people with great reluctance; however, they afterwards determined on ſuch a form of government as threw all the power into their own hands. Twelve palatines, or vaivodes, were choſen; and the Poliſh dominions divided into as many provinces. Theſe palatines exerciſed a deſpotic authority within their ſeveral juriſdictions, and aggravated the miſery of the people by perpetual wars among themſelves; upon which the Poles, worn out with oppreſſion, reſolved to return to their old form of government. Many aſſemblies were held for

for this purpoſe; but, by reaſon of the oppoſition of the vaivodes, they came to nothing. At laſt, however, they caſt their eyes upon Cracus, or Gracus, whoſe wealth and popularity had raiſed him to the higheſt honours among his countrymen. The Poles ſay that he was a native of Poland, and one of the 12 vaivodes; but the Bohemians affirm that he was a native of their country: however, both agree in maintaining, that he was deſcended from the ancient family of the Gracchi in Rome; who, they ſay, were baniſhed to this country. He is ſaid to have ſignalized himſelf againſt the Franks, whom he overthrew in ſome deſperate engagements, and afterwards built the city of Cracow with their ſpoils. He did not enlarge his dominions, but made his ſubjects happy by many excellent regulations. At laſt, after a long and glorious reign, he expired, or, according to ſome, was aſſaſſinated by a nobleman who aſpired to the crown.

Cracus left three children; Cracus, Lechus, and a daughter named *Vanda*. The firſt ſucceeded to the dukedom in virtue of his birthright; but was ſoon after murdered by his brother Lechus. However, it ſeems the thoughts of the crime which he had committed ſo diſturbed his conſcience, that the ſecret could not be kept. When it was known that he had been the murderer of his late ſovereign, he was depoſed with all poſſible marks of ignominy and contempt, and his ſiſter Vanda declared ducheſs. She was a moſt beautiful and accompliſhed lady; and ſoon after ſhe had been raiſed to the ſovereignty, one Rithogar, a Teutonic prince, ſent an ambaſſador demanding her in marriage, and threatening war if his propoſals were refuſed. Vanda marched in perſon againſt him at the head of a numerous army, and the event proved fatal both to Rithogar and herſelf. The troops of Rithogar abandoned him without ſtriking a blow, upon which he killed himſelf in deſpair; and Vanda, having become enamoured of him, was ſo much concerned for his death, that ſhe drowned herſelf in the river Viſtula or Weſel. From this unfortunate lady the country of Vandalia takes its name.

The family of Cracus having become extinct by the death of Vanda, the Poles were again left at liberty to chooſe a new ſovereign or a new form of government. Through a natural levity, they changed the form of government, and reſtored the vaivodes notwithſtanding all that they had formerly ſuffered from them. The conſequences were the ſame as before: the vaivodes abuſed their power; the people were oppreſſed, and the ſtate was diſtracted between foreign wars and civil contentions. At that time the Hungarians and Moravians had invaded Poland with a numerous army, and were oppoſed only by a handful of men almoſt ready to ſurrender at diſcretion. However, one Premiſlaus, a private ſoldier, contrived a ſtratagem by which the numerous forces of the enemy were overthrown; and for his valour was rewarded with the dukedom. We are ignorant of the other tranſactions of his reign; but all hiſtorians inform us that he died deeply regretted, and without iſſue; ſo that the Poles had once more to chooſe a ſovereign.

On the death of Premiſlaus ſeveral candidates appeared for the throne; and the Poles determined to prefer him who could overcome all his competitors in a horſe-race. A ſtone pillar was erected near the capital, on which were laid all the enſigns of the ducal authority; and an herald proclaimed, that he who firſt arrived at that pillar from a river at ſome diſtance, named *Pouderic*, was to enjoy them. A Poliſh lord named *Lechus* was reſolved to ſecure the victory to himſelf by a ſtratagem; for which purpoſe he cauſed iron ſpikes to be driven all over the courſe, reſerving only a path for his own horſe. The fraudulent deſign took effect in part, all the reſt of the competitors being diſmounted, and ſome ſeverely hurt by their fall. Lechus, in conſequence of this victory, was about to be proclaimed duke; when, unluckily for him, a peaſant who had found out the artifice oppoſed the ceremony; and upon an examination of the fact, Lechus was torn in pieces, and the ducal authority conferred upon the peaſant.

Poland.

The name of the new monarch was alſo Lechus. He attained the ſovereignty in the year 774, and behaved with great wiſdom and moderation. Though he poſſeſſed the qualities of a great warrior, and extended his dominions on the ſide of Moravia and Bohemia, yet his chief delight was to make his ſubjects happy by peace. In the decline of life he was obliged to engage in a war with Charlemagne, and is ſaid by ſome to have fallen in battle with that powerful monarch; though others aſſert that he died a natural death, having lived ſo long that the ſprings of life were quite worn out.

Lechus III. was ſucceeded by his ſon Lechus IV. who inherited all his father's virtues. He ſuppreſſed an inſurrection in the Poliſh provinces, by which he acquired great reputation; after which he led his army againſt the Greek and Italian legions who had overrun Panonia. He gained a complete victory over his enemies. Nor was his valour more conſpicuous in the battle than his clemency to the vanquiſhed: for he diſmiſſed all his priſoners without ranſom; demanding no other conditions than that they ſhould never again diſturb the peace of Poland, or the allies of that kingdom. This duke is ſaid to have been endowed with many virtues, and is charged only with the vice of incontinence. He left 20 natural children, and only one legitimate ſon, named *Popiel*, to whom he left the ſovereignty. Popiel was alſo a virtuous and pacific prince, who never had recourſe to arms but through neceſſity. He removed the ſeat of government from Cracow to Gneſna, and was ſucceeded by his nephew Popiel II. a minor.

The young king behaved with propriety as long as he was under the tuition of others; but as ſoon as he had got the reins of government into his own hands the face of affairs was altered. Lechus III. who, as hath been already mentioned, had 20 illegitimate children, had promoted them to the government of different provinces; and they had diſcharged the duties of their offices in ſuch a manner as ſhowed that they were worthy of the confidence repoſed in them. However, as ſoon as Popiel came of age, being ſeduced by the advice of his wife, an artful and ambitious woman, he removed them from their poſts, treated them with the utmoſt contempt, and at laſt found means to poiſon them all at once at an entertainment. A dreadful puniſhment, however, according to the hiſtorians of thoſe times, attended his treachery and cruelty. The bodies of the unhappy governors were left unburied; and from them iſſued a ſwarm of rats, who purſued Popiel, his wife, and children, wherever they went, and at laſt devoured them. The nation now became a prey to civil diſcord at the ſame time that it was

harassed by a foreign enemy; and, in short, the state seemed to be on the verge of dissolution, when Piastus was proclaimed duke in 830, from whom the natives of ducal or regal dignity were called *Piastes*. See PIASTUS. This excellent monarch died in 861, and was succeeded by his son Ziemovitus, who was of a more warlike disposition than his father, and who first introduced a regular discipline among the Polish troops. He maintained a respectable army, and took great pains to acquire a perfect knowledge in the art of war. The consequence of this was, that he was victorious in all his battles; and retook from the Germans and Hungarians not only all that they had gained, but enlarged his dominions beyond what they had been. After his death nothing remarkable happened in Poland till the time of Mieczslaus I. who attained the ducal authority in 964. He was born blind, and continued so for seven years: after which he recovered his sight without using any medicine; a circumstance so extraordinary, that in those times of ignorance and superstition it was accounted a miracle. In his reign the Christian religion was introduced into Poland. The most probable account of the manner in which Christianity was introduced is, that Mieczslaus having by ambassadors made his addresses to Daborwka daughter to the Duke of Bohemia, the lady rejected his offer unless he would suffer himself to be baptized. To this the duke consented, and was baptized, after having been instructed in the principles of Christianity. He founded the archbishoprics of Gnesna and Cracow; and appointed St Adalbert, sent by the pontiff to propagate Christianity in Poland, primate of the whole kingdom. On the birth of his son Boleslaus he redoubled his zeal; founding several bishoprics and monasteries; ordering likewise that, when any part of the Gospel was read, the hearers should half-draw their swords, in testimony of their readiness to defend the faith. He was, however, too superstitious to attend to the duties of a sovereign; and suffered his dominions to be ravaged by his barbarous neighbour the duke of Russia. Yet, with all his devotion, he could not obtain the title of king from the pope, though he had warmly solicited it; but it was afterwards conferred on his son, who succeeded to all his dominions.

9 Why the sovereigns of Poland are called *Piastes*.

10 Christianity introduced by Mieczslaus I.

11 Boleslaus the first king of Poland.

Boleslaus I. the first king of Poland, surnamed *Chrobry*, succeeded to the sovereignty in 999. He also professed and cherished Christianity, and was a man of great valour and prudence. However, the first transaction of his reign savoured very much of the ridiculous piety of those times. He removed from Prague to Gnesna the remains of a saint which he had purchased at a considerable price. The Emperor Otho III. made a pilgrimage, on account of a vow, to the tomb of this saint. He was hospitably received by Boleslaus, whom, in return, he invested with the regal dignity; an act which was confirmed by the pope. This new dignity added nothing to the power of Boleslaus; though it increased his consequence with his own subjects. He now affected more state than before: his body-guards were considerably augmented; and he was constantly attended by a numerous and splendid retinue whenever he stirred out of his palace. Thus he inspired his people with an idea of his greatness, and consequently of their own importance; which no doubt was necessary for the accomplishment of a design he had formed, namely, an offensive war with Russia: but when he was upon the point of setting out on this expedition, he was prevented by the breaking out of a war with the Bohemians. The elevation of Boleslaus to the regal dignity had excited the envy of the duke of Bohemia, who had solicited the same honour for himself, and had been refused. His jealousy was further excited by the connection between Boleslaus and the emperor, the former having married Rixa the emperor's niece. Without any provocation, therefore, or without giving the least intimation of his design, the duke of Bohemia entered Poland at the head of a numerous army, committing everywhere dreadful ravages. Boleslaus immediately marched against him, and the Bohemians retired with precipitation. Scarcity of provisions, and the inclemency of the season, prevented Boleslaus at that time from pursuing; but as soon as these obstacles were removed, he entered Bohemia at the head of a formidable army, with a full resolution of taking an ample revenge. The Bohemians were altogether unable to resist; neither indeed had they courage to venture a battle, though Boleslaus did all in his power to force them to it. So great indeed was the cowardice of the duke or his army, that they suffered Prague, the capital of the duchy, to be taken after a siege of two years; having never, during all that time, ventured to relieve it by fighting the Polish army. The taking of this city was quickly followed by the reduction of all the places of inferior note: but though Boleslaus was in possession of almost all the fortified places in Bohemia, he could not believe his conquests to be complete until he became master of the duke's person. This unfortunate prince had shut himself up with his son in his only remaining fortress of Wissogrod, where he imagined that he should be able to foil all the attempts of the Polish monarch. In this, however, he found himself disappointed. Boleslaus invested the place, and made his approaches with such rapidity, that the garrison, dreading a general assault, resolved to capitulate, and persisted in their resolution notwithstanding all the intreaties and promises of the duke. The consequence was, that the unhappy prince fell into the hands of his enemies, and had his eyes put out by Boleslaus; after which, his son Jaremir was put into perpetual and close confinement.

12 He conquers Bohemia.

From Bohemia Boleslaus marched towards Moravia; but no sooner did he arrive on the frontier than the whole province submitted without a blow. He then resumed his intention of invading Russia; for which he had now a very fair opportunity, by reason of a civil war which raged with violence among the children of duke Volodomir. The chief competitors were Jarislaus and Suantepolk. The latter, having been defeated by his brother, was obliged to take refuge in Poland, where he used all the arguments in his power with king Boleslaus in order to induce him to revenge his cause. Boleslaus having already an intention of invading that country, needed but little intreaty; and therefore moved towards Russia at the head of a very numerous army; giving out, that he had no other design than to revenge the injustice done to Suantepolk. He was met on the banks of the river Bog by Jarislaus at the head of an army much superior in number to his own; and for some days the Polish army was kept at bay by the Russians. At last Boleslaus, growing impatient, resolved to pass the river at all events; and therefore forming his cavalry in the best manner for breaking the torrent,

13 And Moravia.

14 Gains a great victory over the Russians.

land. torrent, he exposed his own person to the utmost of its force. Encouraged by his example, the Poles advanced breast-high in the water to the opposite shore; from whence the enemy gave them all the annoyance in their power. In spite of all opposition, however, the Poles reached the bank, and soon gained a complete victory, Jarislaus being obliged to fly to Kiovia. This city was immediately invested; but Jarislaus retired farther into the country in order to recruit his army, leaving the city to its fate. The garrison made a brave defence, but were at last compelled to surrender at discretion. A vast treasure was found in the place; great part of which was distributed by Boleslaus among the soldiers.

Though the king of Poland had now become master of the greatest part of Russia, he knew that the only
15 es tepolk ie e of a,
possible means of keeping the country in subjection was by placing a natural sovereign over the inhabitants. For this reason he reinstated Suantepolk, though his pretensions were still disputed by Jarislaus. The latter had formed a flying camp, and meditated a scheme of surprising and carrying off his rival brother; but having failed in this attempt, he retired to Novogorod, where the attachment of the inhabitants enabled him to make some resistance, till at last he was attacked and defeated by Boleslaus, which seemed to give the finishing stroke
16 at- s to m off his ar- ut is ed.
to his affairs. The king of Poland, however, now met with a more dangerous enemy in the perfidious and ungrateful Suantepolk than he had experienced in Jarislaus. The Russian prince, imagining himself a dependent on Boleslaus, formed a conspiracy against him; by which he projected nothing less than the destruction of him and his whole army. The massacre was already begun when Boleslaus received intelligence. The urgency of the case admitted of no delay: the king therefore mounted his horse; and having with the utmost haste assembled part of his army, fell upon the traitors with such fury, that they were obliged to betake themselves
7 adful be- the ns oles.
to flight, and Boleslaus got safe into Poland. But in the mean time Jarislaus having assembled fresh forces, pursued the Polish army; and having come up with them just as one half had crossed the river Boristhenes, attacked them with the utmost fury. Boleslaus defended himself with the greatest resolution; but, by reason of his forces being divided, victory was dubious for a long time. At last, when the army had wholly crossed, the Russians were entirely put to the rout, and a terrible carnage ensued. The victory, however, though complete, was not decisive; for which reason Boleslaus thought proper to continue his retreat, without attempting to conquer a country too extensive for him ever to keep in subjection. Still, however, his martial inclina-
red e-
tion continued, and he led his army into Saxony. The inhabitants of this country had hitherto resisted all attempts that had been made on their freedom, and still made a violent struggle for liberty; though, in spite of their utmost efforts, they were obliged at last to submit to the yoke. On his withdrawing the troops from Saxony, however, the king thought proper to leave the people to their liberty, contenting himself with a rich booty. The boundaries of his empire he now fixed at the river Elbe; where he erected two iron columns, in order to transmit the memory of his conquest to posterity.

Boleslaus, still unsated with victory, now meditated the conquest of Prussia and Pomerania; the latter of which provinces had, in the former civil wars, been dismembered from Poland. His arms were attended with equal success against both: indeed the very terror of his name seemed to answer all the purposes of a formidable army. These, however, he seems to have designed to be the last of his warlike enterprises; for he now applied himself wholly to the enacting of wholesome laws for the benefit of his people. But in the midst of this tranquillity Jarislaus assembled the most numerous army that had ever been heard of in Russia, with which he appeared on the frontiers of Poland. Boleslaus, though now advanced in years, marched out against his adversaries, and met them on the banks of the Boristhenes, rendered famous by the victory he had lately gained there. The Poles crossed the river by swimming; and attacked the enemy before they had time to draw up in order of battle with such impetuosity, that a total rout soon ensued. The Russians were seized with a panic, and Jarislaus was hurried away, and almost trampled to death by the fugitives. Many thousand prisoners were taken, but Boleslaus released them upon very easy conditions; contenting himself with an inconsiderable tribute, and endeavouring to engage the affections of the people by his kindness. This well-timed clemency produced such an happy effect, that the Russians voluntarily submitted to his jurisdiction, and again became his subjects. Soon after this he died in the year 1025, after having vastly extended his dominions, and rendered his subjects happy.

Poland.

19 With Prussia and Pomerania.

20 Gains another great victory over the Russians, on which the whole country submits.

21 Boleslaus dies.

Boleslaus was succeeded by his son Mieczslaus II. but he possessed none of the great qualities of his father, being indolent and debauched in his behaviour. In the very beginning of his reign, the Russians, Bohemians, and Moravians, revolted. However, as the spirit and discipline introduced by Boleslaus still remained in the Polish army, Mieczslaus found no great difficulty in reducing them again to obedience: after which, devoting himself entirely to voluptuousness, he was seized with a frenzy, which put an end to his life in the year 1034. The bad qualities of this prince proved very detrimental to the interest of his son Casimir; though the latter had received an excellent education, and was possessed of many virtues. Instead of electing him king, they chose Rixa his mother queen-regent. She proved tyrannical, and so partial to her countrymen the Germans, that a rebellion ensued, and she was forced to fly to Germany; where she obtained the protection of the emperor by means of the immense treasures of Boleslaus, which she had caused to be transported thither before her. Her bad behaviour and expulsion proved still more fatal to the affairs of Casimir than even that of his father. He was immediately driven out of the kingdom; and a civil war taking place, a great many pretenders to the crown appeared at once. To the miseries occasioned by this were added those of a foreign war; for the Bohemians and Russians invaded the kingdom in different places, committing the most dreadful ravages. The consequence of these accumulated distresses was, that the nobility came at last to the resolution of recalling Casimir, and electing him sovereign. However, before they took this measure, it was thought proper to send to Rome to complain of the behaviour of the duke of Bohemia. The deputies were at first received favourably: but

22 Rixa, a tyrannical regent, driven out with her son Casimir.

23 Poland distressed by foreign and domestic wars.

Poland.

but the influence of the duke's gold prevailing, no redress was obtained; so that at last it was resolved, without more ado, to send for Casimir.

24 Casimir recalled and elected king.

The only difficulty was where to find the fugitive prince; for he had been gone five years from the kingdom, and nobody knew the place of his retreat. At last, by sending an embassy to his mother, it was found out that he had retired into France, where he applied closely to study at the university of Paris. Afterwards he went to Italy; where, for the sake of subsistence, he took upon him the monastic habit. At that time he had returned to France, and obtained some preferment in the abbey of Clugni. Nothing now obstructed the prince's return but the sacred function with which he was invested. However, a dispensation was obtained from the pope, by which he was released from his ecclesiastical engagements, on condition that he and all the kingdom should become subject to the capitation tax called *Peter-pence*. Some other conditions of less consequence were added; such as, that the Poles should shave their heads and beards, and wear a white linen robe at festivals, like other professors of the Catholic religion. Great preparations were made for the reception of the young prince: and he was met on the frontier by the nobility, clergy, and forces of the nation; by whom he was conducted to Gnesna, and crowned by the primate with more than usual solemnity. He proved a virtuous and pacific prince, as indeed the distracted situation of the kingdom would not admit of the carrying on of wars. However, Casimir proved his courage in subduing the banditti by which the country was over-run; and by marrying the princess Mary, sister to the duke of Russia, all quarrels with that nation were for the present extinguished. Upon the whole, the kingdom flourished during his reign; and became more respectable from the wisdom and stability of the administration than it could have been by many victories. After a happy reign of 16 years, he died beloved and regretted by all his subjects.

25 Poland subjected to the tax called *Peter-pence*.

26 Boleslaus II. a valiant and successful prince.

By the happy administration of Casimir the kingdom recovered sufficient strength to carry on successful wars against its foreign enemies. Boleslaus II. the son of Casimir, an enterprising and valiant prince, succeeded to the throne; and soon made himself so famous, that three unfortunate princes all took refuge at his court at once, having been expelled from their own dominions by their rebellious subjects. These were, Jacomir, son of Briteslaus duke of Bohemia; Bela, brother to the king of Hungary; and Zaslaus duke of Kiovia, eldest son to Jarislaus duke of Russia, and cousin to the king of Poland. Boleslaus determined to redress all their grievances; but while he deliberated upon the most proper means for so doing, the duke of Bohemia, dreading the consequence of Jacomir's escape, assembled an army, and, without any declaration of war, marched through the Hercynian forest, desolated Silesia, and laid waste the frontiers of Poland with fire and sword. Boleslaus marched against him with a force greatly inferior; and, by mere dint of superior capacity, cooped up his adversary in a wood, where he reduced him to the greatest distress. In this extremity the duke sent proposals for accommodation; but they were rejected with disdain by Boleslaus; upon which the former, ordering fires to be kindled in his camp, as if he designed to continue there, removed with the utmost silence in the night-time; and marching through narrow defiles, was advanced several leagues before Boleslaus received advice of his retreat. The king pursued him, but in vain; for which reason he returned, after having ravaged the frontiers of Moravia. The next year he entered Bohemia with a numerous army; but the duke, being unwilling to encounter such a formidable adversary, submitted to such terms as Boleslaus thought proper to impose. In these the king of Poland stipulated for certain conditions in favour of Jacomir, which he took care to see punctually executed; after which he determined to march towards Hungary, to assist the fugitive prince Bela.

27 Entertains three unfortunate princes.

28 Affords effectual succour to Jacomir prince of Bohemia,

This prince had been for some time solicited by a party of disaffected nobility to return, as his brother, the reigning king, had alienated the hearts of his subjects by his tyrannical behaviour: as soon therefore as Boleslaus had finished the war in Bohemia, he was solicited by Bela to embrace so favourable an opportunity, and put him in possession of the kingdom of Hungary. This the king readily complied with, as being agreeable to his own inclinations; and both princes entered Hungary by different routes, each at the head of a numerous body. The king of that country, however, was not disconcerted by such a formidable invasion; and being largely assisted by the emperor, advanced against his antagonists with a vast army; among whom was a numerous body of Bohemians, who had come to his assistance, though in direct violation of the treaty subsisting between the duke and the king of Poland. At last a decisive battle was fought, in which the Germans behaved with the greatest valour, but were entirely defeated through the treachery of the Hungarians, who in the heat of the battle deserted and went over to Bela. Almost all the foreign auxiliaries were killed on the spot; the king himself was seized, and treated with such insolence by his perfidious subjects, that he died in a short time of a broken heart; so that Bela was placed on the throne without further opposition, except from a revolt of the peasants, which was soon quelled by the Polish army.

Boleslaus, having succeeded so happily in these two enterprises, began to look upon himself as invincible; and, instead of designing only to assist Zaslaus, as he had first intended, now projected no less than the subjection of the whole country. He had indeed a claim to the sovereignty by virtue of his descent from Mary, queen of Poland, sister to Jarislaus; and this he endeavoured to strengthen by marrying a Russian princess himself. Having therefore assembled a very numerous and well-disciplined army, he entered the duchy of Kiovia, where he was opposed by Wisseslaus, who had usurped the sovereignty, with a vast multitude of forces. Boleslaus, however, continued to advance; and the Russian prince being intimidated by the number and good order of his enemies, deserted his own troops, and fled away privately with a slender retinue; upon which his force dispersed themselves for want of a leader. The inhabitants of the city of Kiovia now called to their assistance Suantoslaus and Wszevold two brothers of Wisseslaus; but these princes acting the part of mediators, procured pardon for the inhabitants from Zaslaus their natural sovereign. With the same facility the two princes recovered all the other dominions belonging to Zaslaus; only one city venturing to stand a siege, and that was soon reduced. But in the mean time the king of

oland

of Hungary dying, a revolt enſued, and the two ſons of Bela were on the point of being deprived of their paternal dominions. This Boleſlaus no ſooner heard than he marched directly into Hungary; where by the bare terror of his name, he re-eſtabliſhed tranquillity, and confirmed the princes in the enjoyment of their kingdom. In the time that this was doing, Zaſlaus was again driven from his territories, all the conqueſts that had been formerly made were loſt, and Suantoſlaus and Wſzevold more powerful than ever. The king's vigour, however, ſoon diſconcerted all their meaſures. He ravaged all thoſe territories which compoſed the palatinates of Luſac and Chelm, reduced the ſtrong city of Wolyn, and tranſported the booty to Poland. The campaign was finiſhed by a battle with Wſzevold; which proved ſo bloody, that though Boleſlaus was victorious, his army was weakened in ſuch a manner that he could not purſue his conqueſts. In the winter he made numerous levies; and returning in the ſpring to Kiovia, reduced it, after ſeveral deſperate attacks, by famine. On this occaſion, inſtead of treating the inhabitants with cruelty, he commended their valour, and ſtrictly prohibited his troops from pillaging or inſulting them; diſtributing proviſions among them with the utmoſt liberality.

32 educes iovia, but ervates mſelf ere.

This clemency procured the higheſt honour to the king of Poland; but his ſtay here produced a moſt terrible diſaſter. Kiovia was the moſt diſſolute, as well as the richeſt city, in the north; the king and all his ſoldiers gave themſelves up to the pleaſures of the place. Boleſlaus himſelf affected all the imperious ſtate of an eaſtern monarch, and contracted an inclination for the groſſeſt debaucheries. The conſequence had almoſt proved fatal to Poland. The Hungarian and Ruſſian wars had continued for ſeven years, during all which time the king had never been at home excepting once for the ſhort ſpace of three months. In the mean time the Poliſh women, exaſperated at hearing that their huſbands had neglected them and connected themſelves with the women of Kiovia, raiſed their ſlaves to the beds of their maſters; and in ſhort the whole ſex conſpired in one general ſcheme of proſtitution, in order to be revenged of the infidelity of their huſbands, excepting one ſingle woman, namely, *Margaret*, the wife of Count Nicholas of Demboiſin, who preſerved her fidelity in ſpite of all ſolicitation. Advice of this ſtrange revolution was ſoon received at Kiovia, where it excited terrible commotions. The ſoldiers blamed the king for their diſhonour; forgetting how much they had to accuſe their own conduct in giving their wives ſuch extreme provocation. The effect of theſe diſcontents was a general deſertion, and Boleſlaus ſaw himſelf ſuddenly left almoſt alone in the heart of Ruſſia; the ſoldiers having unanimouſly reſolved to return home to take vengeance of their wives and their gallants.

33 niverſal efection f the Po iſh woen.

A dreadful kind of war now enſued. The women knew that they were to expect no mercy from their enraged huſbands, and therefore perſuaded their lovers to take arms in their defence. They themſelves fought by the ſide of their gallants with the utmoſt fury, and ſought out their huſbands in the heat of battle, in order to ſecure themſelves from all danger of puniſhment by their death. They were, however, on the point of being ſubdued, when Boleſlaus arrived with the few remaining Poles, but aſſiſted by a vaſt army of Ruſſians, with whom he intended to take equal vengeance on the women, their gallants, and his own ſoldiers who had deſerted him. This produced a carnage more dreadful than ever. The ſoldiers united with their former wives and their gallants againſt the common enemy, and fought againſt Boleſlaus and his Ruſſians with the fury of lions. At laſt, however, the fortune of the king prevailed; the rebels were totally ſubdued, and the few who eſcaped the ſword were tortured to death, or died in priſon.

34 A terrible ivil war nſues.

Poland.

35 Religious contentions.

To add to the calamities of this unhappy kingdom, the ſchiſms which for ſome time had prevailed in the church of Rome found their way into Poland alſo; and the animoſity of parties became aggravated in proportion to the frivolouſneſs of their differences. By perverſe accident the matter came at laſt to be a contention for wealth and power between the king and clergy. This ſoon gave occaſion to bloodſhed; and the biſhop of Cracow was maſſacred in the cathedral while he was performing the duties of his office. This and ſome other enormous crimes in a ſhort time brought on the moſt ſignal vengeance of the clergy. Gregory VII. the pope at that time, thundered out the moſt dreadful anathemas againſt the king, releaſed his ſubjects from their allegiance, deprived him of the titles of ſovereignty, and laid the kingdom under a general interdict, which the archbiſhop of Gneſna ſaw punctually enforced. To this terrible ſentence Boleſlaus in vain oppoſed his authority, and recalled the ſpirit which had formerly rendered him ſo formidable to the neighbouring ſtates. The minds of the people were blinded by ſuperſtition, ſo that they deemed it a leſs heinous crime to riſe in rebellion againſt their ſovereign than to oppoſe the tyranny of the holy ſee. Conſpiracies were daily formed againſt the perſon and government of Boleſlaus. The whole kingdom became a ſcene of confuſion, ſo that the king could no longer continue with ſafety in his own dominions. He fled therefore with his ſon Mieczſlaus, and took refuge in Hungary; but here alſo the holy vengeance of the clergy purſued him, nor did they ceaſe perſecuting him till he was brought to a miſerable end. Authors differ widely with reſpect to the manner of his death. Some ſay that he was murdered by the clergy as he was hunting; others, that he killed himſelf in a fit of deſpair; and one author tells us, that he wandered about in the woods of Hungary, lived like a ſavage upon wild beaſts, and was at laſt killed and devoured by dogs. The greateſt number, however, tell us, that being driven from place to place by the perſecutions of the clergy, he was at laſt obliged to become a cook in a monaſtery at Carinthia, in which mean occupation he ended his days.

36 Boleſlaus depoſed by the pope, and the whole kingdom put under an interdict.

37 The king's extreme diſtreſs and death.

38 The interdict removed at the expence of grievous impoſitions.

The deſtruction of Boleſlaus was not ſufficient to allay the papal reſentment. It extended to the whole kingdom of Poland. Mieczſlaus, the ſon of Boleſlaus, was not ſuffered to aſcend the throne; and the kingdom continued under the moſt ſevere interdict, which could be removed only by the force of gold, and the moſt abject conceſſions. Beſides the tax called *Peter-pence*, new impoſitions were added of the moſt oppreſſive nature; till at length the pontiff, having ſatiated his avarice, and impoveriſhed the country, conſented that the brother of the deceaſed monarch ſhould be raiſed to the ſovereignty, but only with the title of duke. This prince, named *Uladiſlaus*, being of a meek diſpoſition, with

Poland.

39 Uladislaus becomes sovereign, but is allowed only the title of duke.

with little ambition, thought it his duty to acquiesce implicitly in the will of the pope; and therefore accepted the terms offered, sending at the same time an embassy to Rome, earnestly intreating the removal of the interdict. The request was granted; but all his endeavours to recover the regal dignity proved fruitless, the pope having, in conjunction with the emperor of Germany, conferred that honour on the duke of Bohemia. This was extremely mortifying to Uladislaus, but it was absorbed in considerations of the utmost consequence to himself and his dominions. Russia took the opportunity of the late civil disturbances to throw off the yoke; and this revolt drew after it the revolt of Prussia, Pomerania, and other provinces. The smaller provinces, however, were soon reduced; but the duke had no sooner returned to Poland, than they again rebelled, and hid their families in impenetrable forests. Uladislaus marched against them with a considerable army; but was entirely defeated, and obliged to return back with disgrace. Next year, however, he had better fortune; and, having led against them a more numerous army than before, they were content to submit and deliver up the ringleaders of the revolt to be punished as the duke thought proper.

No sooner were the Pomeranians reduced, than civil dissensions took place. Sbigneus, the son of Uladislaus by a concubine, was placed at the head of an army by the discontented nobility, in order to subvert his father's government, and dispute the title of Boleslaus, the legitimate son of Uladislaus, to the succession. The war was terminated by the defeat and captivity of Sbigneus; who was at first confined, but afterwards released on condition that he should join his father in punishing the palatine of Cracow. But before this could be done, the palatine found means to effect a reconciliation with the duke; with which the young princes being displeased, a war took place between them and their father. The end of all was, that the palatine of Cracow was banished, and the princes submitted; after which, Uladislaus, having chastised the Prussians and Pomeranians who had again revolted, died in the year 1103, the 59th of his age.

40 Boleslaus III. divided his dominions betwixt Sbigneus his illegitimate brother and himself.

Uladislaus was succeeded by his son Boleslaus III. who divided the dominions equally betwixt his brother Sbigneus and himself. The former being dissatisfied with his share, raised cabals against his brother. A civil war was for some time prevented by the good offices of the primate: but at last Sbigneus, having privately stirred up the Bohemians, Saxons, and Moravians, against his brother, made such formidable preparations as threatened the conquest of all Poland. Boleslaus, being unprovided with forces to oppose such a formidable power, had recourse to the Russians and Hungarians; who readily embraced his cause, in expectation of turning it to their own advantage. The event was, that Sbigneus was entirely defeated; and might easily have been obliged to surrender himself at discretion, had not Boleslaus generously left him in quiet possession of the duchy of Mazovia, in order to maintain himself suitably to the dignity of his birth. This kindness the ungrateful Sbigneus repaid by entering into another conspiracy; but the plot being discovered, he was seized, banished, and declared a traitor if ever he set foot again in Poland. Even this severity did not produce the desired effect; Sbigneus persuaded the Pomeranians to arm in his behalf; but he was defeated, taken prisoner, and again banished. Almost all the nobility solicited the king to put such an ungrateful traitor to death; however, that generous prince could not think of polluting his hands with the death of his brother, notwithstanding all he had yet done. Nay, he even took him back to Poland, and appointed him a maintenance suitable to his rank: but he soon had reason to repent his kindness; for his unnatural brother in a short time began to raise fresh disturbances, in consequence of which he soon met with the death which he deserved.

41 A civil war.

42 Generosity of Boleslaus, and ingratitude of Sbigneus,

43 Who is at last put to death.

Boleslaus was scarce freed from the intrigues of his brother, when he found himself in greater danger than ever from the ambition of the emperor Henry IV. The emperor had attacked the king of Hungary, with whom Boleslaus was in close alliance, and from whom he had received assistance when in great distress himself. The king of Poland determined to assist his friend; and therefore made a powerful diversion in Bohemia, where he repeatedly defeated the Imperialists: upon which, the emperor collecting all his forces, ravaged Silesia, and even entered Poland, where he laid siege to the strong town of Lubusz; but was at last obliged to abandon the enterprise, after having sustained much loss. However, Henry was not discouraged, but penetrated still farther into Poland, and was laying waste all before him, when the superior skill of Boleslaus compelled him to retire, after having almost destroyed his army with fatigue and famine, without once coming to action. Enraged at this disappointment, Henry laid siege to Glogaw, in hopes of drawing the Poles to an engagement before he should be obliged to evacuate the country. The fortifications of the place were weak; but the spirit of the inhabitants supplied their deficiencies, and they gave the Imperialists a most unexpected and vigorous reception. At last, however, they were on the point of surrendering to superior force; and actually agreed to give up the place, provided they did not receive any succours during that time. Boleslaus determined, however, not to let such a brave garrison fall a sacrifice to their loyalty; and therefore prevailed on the besieged to break the capitulation rather than surrender when they were on the point of being delivered. All this was transacted with the utmost secrecy; so that the emperor advanced, without thoughts of meeting with any resistance, to take possession of the city; but, being received by a furious discharge of arrows and javelins, he was so incensed, that he resolved to storm the place, and give no quarter. On the approach of the army, the Imperialists were astonished to see not only the breaches filled up, but new walls, secured by a wet ditch, reared behind the old, and erected during the suspension of hostilities by the industry of the besieged. The attack, however, went on; but the inhabitants, animated by despair, defended themselves with incredible valour, and at last obliged the Imperialists to break up the siege with precipitation. Next day Boleslaus arrived, and pursued the emperor with such vigour, that he obliged him to fly with disgrace into his own country. This soon brought on a peace, which was confirmed by a marriage between Boleslaus and the emperor's sister.

44 War with the emperor Henry IV.

45 Who is worsted.

Hitherto the glory of Boleslaus had equalled, or even eclipsed, that of his namesake and predecessor Boleslaus the Great; but about the year 1135 he was brought

46 Boleslaus brought into difficulties by his own credulity and generosity.

brought into difficulties and disgrace by his own credulity. He was imposed upon by an artful story patched up by a certain Hungarian; who insinuated himself so far into his affections, that he gave him the government of Wislica, a strong town on the river Nida. But the traitor gave up the place to the Russians, who pillaged and burnt it; carrying the inhabitants at the same time into slavery. Boleslaus was incensed, and entered immediately upon a war with Russia, by which means he only heaped one calamity upon another. He received a deputation from the inhabitants of Halitz, to implore his assistance in favour of a young prince, who had been banished into Poland. Boleslaus marched to their relief with a choice body of troops; but as he was preparing to enter the town, he was attacked by the whole Russian army, and, after a most violent conflict, entirely defeated. By this disgrace the duke was so much afflicted, that he died in a short time, after having reigned 36 years.

Boleslaus, by his will, left his dominions equally divided among his four sons. Uladislaus, the eldest, had the provinces of Cracow, Sirad, Lencici, Silesia, and Pomerania. Boleslaus, the second son, had for his share the palatinates of Culm and Cujava, with the duchy of Mazovia. The palatinates of Kaleszh and Posnania fell to Mieczslaus the third son; and to Henry, the fourth son, were assigned those of Lublin and Sandomir. Casimir the youngest child, then an infant in the cradle, was entirely forgot, and no provision made for him. There have been but very few instances where dominions were thus divided, that the princes remained satisfied with their respective shares; neither did the sons of Boleslaus long continue at peace with one another. By the will of the late duke, all the brothers were obliged to own the supremacy of Uladislaus, who was declared duke of all Poland: they were restrained from forming alliances, declaring war, or concluding peace, without his approbation: they were obliged to take the field with a certain number of troops, whenever the duke required it; and they were forbid to meddle with the guardianship of the infant prince Casimir, his education being left entirely to the sovereign. The harmony of the princes was first disturbed by the ambition of Christina, the wife of Uladislaus, who formed a scheme to get possession of all Poland, and deprive the younger children of the benefit of their father's will. Having obtained her husband's concurrence, she assembled the states of Poland, and made a long speech, showing the dangers which might arise from a partition of the ducal dominions among so many; and concluded with attempting to show the necessity of revoking the ratification of the late duke's will, in order to ensure the obedience of the princes and the tranquillity of the republic. Many of the nobility expressed their resentment against this speech, and fully refuted every article in it; but they were all afterwards gained over, or intimidated by Uladislaus; so that none appeared to take the part of the young princes except a noble Dane, who lost his life for so doing.

Uladislaus now having got the nobility on his side, first drove Boleslaus out of his territories; next, he marched against Henry, and dispossessed him also, forcing both to take refuge with Mieczslaus in Posnania, where all the three brothers were besieged. Several of the nobility interposed, and used all their influence to effect a reconciliation, but in vain; for Uladislaus was as inexorable as if he had received an injury, and therefore insisted that the besieged princes should surrender at discretion, and submit to the will of the conqueror. Thus driven to despair, the brothers sallied out, and attacked the duke's army with such impetuosity, that they obtained a complete victory, and took all his baggage and valuable effects. The brothers improved their victory, and laid siege to Cracow. The Russians, who had assisted Uladislaus at first, now entirely abandoned him, and evacuated Poland, which obliged him to shut himself up in Cracow; but, finding the inhabitants little disposed to stand a siege, he retired into Germany in order to solicit assistance from his wife's friends. But here he found himself mistaken, and that these friends were attached to him only in his prosperity; while in the mean time the city of Cracow surrendered, the unfortunate Uladislaus was formally deposed, and his brother Boleslaus raised to the supreme authority. 50 And is deposed.

The new duke began his administration with an act of generosity to his brother Uladislaus, to whom he gave the duchy of Silesia, which thus was separated from Poland, and has never since been re-annexed to it. This had no other effect upon Uladislaus than the putting him in a condition to raise fresh disturbances; for he now found means to persuade the emperor Conrade to invade Poland: but Boleslaus so harassed and fatigued his army by perpetual marches, ambuscades, and skirmishes, that he was obliged in a short time to return to his own country; and for some years Poland enjoyed a profound tranquillity.

During this interval Henry entered on a crusade; and, though he lost almost all his army in that enthusiastic undertaking, he is celebrated by the superstitious writers of that age, as the bulwark of the church, and one of the greatest Christian heroes: however, in all probability, the reason of this extraordinary fame is, that he made large donations to the knights of St John of Jerusalem. Soon after the return of Henry, Poland was invaded by the emperor Frederic Barbarossa, who was persuaded to this by the solicitations of Uladislaus and his wife Christina. The number of the Imperialists was so great, that Boleslaus and his brothers did not think proper to oppose them in the field; they contented themselves with cutting off the convoys, placing ambuscades, harassing them on their march, and keeping them in perpetual alarms by false attacks and skirmishes. With this view the three brothers divided their forces, desolated the country before the enemy, and burnt all the towns and cities which were in no condition to stand a siege. Thus the emperor, advancing into the heart of a desolated country where he could not subsist, was at last reduced to such a situation that he could neither go forward nor retreat, and was obliged to solicit a conference with Boleslaus. The latter was too prudent to irritate him by an unseasonable haughtiness, and therefore went to the German camp attended only by his brothers and a slight guard. This instance of confidence was so agreeable to the emperor, that a treaty was soon agreed upon, which was confirmed by a marriage between Adelaide, niece to the emperor, and Mieczslaus duke of Posnania.

51 Poland invaded by the emperor Barbarossa.

52 Who is obliged to sue for peace.

Boleslaus having thus happily escaped from so great a danger, took it into his head to attempt the conquest of Prussia, for no other reason but because the inhabitants

Poland. tants were heathens. Having unexpectedly invaded the country with a very numerous army, he succeeded in his enterprise; great numbers of infidels were converted, and many churches set up: but no sooner was Boleslaus gone, than the inhabitants returned to their old religion. Upon this Boleslaus again came against them with a formidable power; but, being betrayed by some Prussians whom he had taken into his service and raised to posts of honour, his army was led into defiles and almost entirely cut off, duke Henry was killed, and Boleslaus and Mieczslaus escaped with great difficulty.

This misfortune was quickly followed by another; for now the children of Uladislaus laid claim to all the Polish dominions which had been possessed by their father, most of which had been bestowed upon young Casimir. They were supported in their pretensions by a great number of discontented Poles, and a considerable body of German auxiliaries. Boleslaus, finding himself unable to withstand his enemies by force, had recourse to negociation, by which means he gained time to recruit his army and repair his losses. An assembly of the states was held, before which the duke so fully refuted the claims of the children of Uladislaus, that it was almost unanimously voted that they had kindled an unjust war; and to take away every pretence for renewing the civil discords of Poland, they were a second time invested with the duchy of Silesia, which for the present put an end to all disputes. After this, Boleslaus applied himself to promote, by all means, the happiness of his subjects, till his death, which happened in the year 1174.

53 A civil war.

On the death of Boleslaus, the states raised his brother Mieczslaus to the ducal throne, on account of the great opinion they had of him. But the moment that Mieczslaus ceased to be a subject, he became a tyrant, and a slave to almost every kind of vice; the consequence of which was, that in a very short time he was deposed, and his brother Casimir elected in his stead.

54 Casimir, an excellent prince,

Casimir was a prince of the greatest justice and benevolence, insomuch that he scrupled to accept of the honour which the states had conferred upon him, lest it should be a trespass against the laws of equity. However, this scruple being soon got over, he set himself about the securing peace and tranquillity in all parts of his dominions. He redressed all grievances, suppressed exorbitant imposts, and assembled a general diet, in which it was proposed to rescue the peasants from the tyranny of the nobility; an affair of such consequence, that the duke could not enter upon it by his own authority, even though supported by the clergy. Yet it proved less difficult than had been imagined, to persuade the nobility to relinquish certain privileges extremely detrimental to natural right. They were influenced by the example of their virtuous sovereign, and immediately granted all that he required; and, to secure this declaration in favour of the peasants, the archbishop of Gnesna thundered out anathemas against those who should endeavour to regain the unjust privileges which they had now renounced; and to give a still greater weight to this decision, the acts of the diet were transmitted to Rome, where they were confirmed by the pope.

But though the nobility in general consented to have their power somewhat retrenched, it proved matter of discontent to some, who for this reason immediately became the partisans of the deposed Mieczslaus. This unfortunate prince was now reduced to such indigence, that he wrote an account of his situation to his brother Casimir; which so much affected him, that in an assembly of the diet he proposed to resign the sovereignty in favour of his brother. To this the states replied in the most peremptory manner: they desired him never more to mention the subject to them, lest they should be under the necessity of deposing him and excluding his brother, who, they were determined, should never more have the dominion of Poland. Casimir, however, was so much concerned at the account of his brother's misfortunes, that he tried every method to relieve him, and even connived at the arts practised by some discontented noblemen to restore him. By a very singular generosity, he facilitated the reduction of Gnesna and Lower Poland, where Mieczslaus might have lived in peace and splendor, had not his heart been so corrupted that it could not be subdued by kindness. The consequence was, that he used all his art to wrest from his brother the whole of his dominions, and actually conquered the provinces of Mazovia and Cujava; but of these he was soon dispossessed, and only some places in Lower Poland were left him. After this he made another attempt, on occasion of a report that Casimir had been poisoned in an expedition into Russia. He surprised the city of Cracow: but the citadel refused to surrender, and his hopes were entirely blasted by the return of Casimir himself; who, with an unparalleled generosity and magnanimity, asked peace of his brother whom he had vanquished and had in a manner at his mercy.—The last action of this amiable prince was the conquest of Russia, which he effected rather by the reputation of his wisdom and generosity than by the force of his arms. Those barbarians voluntarily submitted to a prince so famed for his benevolence, justice, and humanity. Soon after his return, he died at Cracow, lamented as the best prince in every respect who had ever filled the throne of Poland.

55 Conq[uers] Russia.

Casimir left one son, named *Lechus*, an infant; and the states, dreading the consequences of a long minority, hesitated at appointing him sovereign, considering how many competitors he must necessarily have, and how dubious it must be whether he might be fit for the sovereignty after he had obtained it. At last, however, Lechus was nominated, chiefly through the interest he had obtained on account of the reputation of his father's virtues. The consequence of his nomination was precisely what might have been expected. Mieczslaus formed an alliance against him with the dukes of Oppelen, Pomerania, and Breslau; and having raised all the men in Lower Poland fit to bear arms, took the road to Cracow with a very numerous army. A bloody battle was fought on the banks of the river Mozgarva; in which both sides were so much weakened, that they were unable to keep the field, and consequently were forced to retire for some time in order to repair their forces. Mieczslaus was first ready for action, and therefore had the advantage: however, he thought proper to employ artifice rather than open force; and therefore having attempted in vain to corrupt the guardians of Lechus, he entered into a treaty with the duchess-dowager his mother. To her he represented in the strongest manner the miseries which would ensue from her refusal of the conditions he proposed. He stipulated to adopt Lechus and Conrade, her sons, for his own; to

5[6] Civil [war] betw[een] Lech[us and] the d[uke] Miec[zslaus].

 surrender

surrender the province of Cujavia for their present support; and to declare them heirs to all his dominions. The principal nobility opposed this accommodation, but it was accepted by the duchess in spite of all their remonstrances; and Mieczslaus was once more put in possession of the capital, after having taken a solemn oath to execute punctually every article of the treaty.

It is not to be supposed that a prince of such a perfidious disposition as Mieczslaus would pay much regard to the obligations of a simple contract. It was a maxim with him, that a sovereign is no longer obliged to keep his oath than while it is neither safe nor beneficial to break it. Having therefore got all the power into his hands, he behaved in the very same manner as if no treaty with the duchess had subsisted. The duchess, perceiving herself duped, formed a strong party, and excited a general insurrection. The rebellion could not be withstood: Mieczslaus was driven out of Cracow, and on the point of being reduced to his former circumstances, when he found means to produce a variance between the duchess and palatine of Cracow; and thus once more turned the scale in his favour. The forces of Mieczslaus now became superior, and he, in consequence, regained possession of Cracow, but did not long enjoy his prosperity, falling a victim to his intemperance; so that Lechus was restored to the sovereignty in the year 1206.

The government of Lechus was the most unfortunate of any of the sovereigns of Poland. In his time the Tartars made an irruption, and committed everywhere the most cruel ravages. At last they came to an engagement with the Poles, assisted by the Russians; and after an obstinate and dreadful conflict, obtained a complete victory. This incursion, however, terminated as precipitately as it commenced; for without any apparent reason they retired, just as the whole kingdom was ready to submit; but the devastations they had committed produced a famine, which was soon followed by a plague that depopulated one of the most populous countries of the north. In this unhappy situation of affairs, death ended the misfortunes of Lechus, who was murdered by his own subjects as he was bathing. A civil war took place after his death; and the history for some time is so confused, that it is difficult to say with certainty who was his successor. During this unfortunate state of the country, the Tartars made a second irruption, laid all desolate before them, and were advancing to the capital, when they were attacked and defeated with great slaughter by the palatine of Cracow with only a handful of men. The power of the enemy, however, was not broken by this victory; for, next year, the Tartars returned, and committed such barbarities as can scarce be imagined. Whole provinces were defeated, and every one of the inhabitants massacred. They were returning, laden with spoil, when the palatine fell upon them a second time, but not with the same success as before: for, after an obstinate engagement, he was defeated, and thus all Poland was laid open to the ravages of the barbarians; the nobility fled into Hungary, and the peasants sought an asylum among rocks and impenetrable forests. Cracow, being left entirely defenceless, was soon taken, pillaged, and burnt; after which the barbarians, penetrating into Silesia and Moravia, desolated these countries, destroying Breslau and other cities. Nor did Hungary escape the fury of their barbarity: the king gave battle to the Tartars, but was defeated with vast slaughter, and had the mortification to see his capital laid in ashes, and above 100,000 of his subjects perish by fire and sword. The arms of the Tartars were invincible; nothing could withstand the prodigious number of forces which they brought into the field, and the fury with which they fought. They fixed their head-quarters on the frontiers of Hungary; and spread their devastations on every side with a celerity and success that threatened the destruction of the whole empire, as well as of the neighbouring kingdoms.

In this dreadful situation was Poland when Boleslaus, surnamed the *Chaste*, was raised to the sovereignty; but this, so far from putting an end to the troubles, only superadded a civil war to the rest of the calamities. Boleslaus was opposed by his uncle Conrade the brother of Lechus, who was provoked at becoming the subject of his own nephew. Having assembled a powerful army, he gained possession of Cracow; assumed the title of *Duke of Poland*; and might possibly have kept possession of the sovereignty, had not his avarice and pride equally offended the nobility and peasants. In consequence of their discontents, they unanimously invited Boleslaus, who had fled into Hungary, to come and head the insurrection which now took place in every quarter. On his arrival, he was joyfully received into the capital: but Conrade still headed a powerful party; and it is reported that on this occasion the knights of the Teutonic order were first called into Poland, to dispute the pretensions of Boleslaus. All the endeavours of Conrade, however, proved unsuccessful: he was defeated in two pitched battles, and forced to live in a private situation; though he never ceased to harass his nephew, and make fresh attempts to recover the crown. However, of the reign of Boleslaus we have little account, except that he made a vow of perpetual continency, and imposed the same on his wife; that he founded near 40 monasteries; and that he died after a long reign in 1279, after having adopted Lechus duke of Cujavia, and procured a confirmation of his choice by the free election of the people.

59 Knights of the Teutonic order first called into Poland.

60 Poland over-run by the Russians, Tartars, and Lithuanians.

The reign of this last prince was one continued scene of foreign and domestic trouble. On his first accession he was attacked by the united forces of Russia and Lithuania assisted by the Tartars; whom, however, he had the good fortune to defeat in a pitched battle. By this victory the enemy were obliged to quit the kingdom; but Lechus was so much weakened, that civil dissensions took place immediately after. These increased to such a degree, that Lechus was obliged to fly to Hungary, the common resource of distressed Polish princes. The inhabitants of Cracow alone remained firm in their duty; and these brave citizens stood all the fatigue and danger of a tedious siege, till they were at last relieved by Lechus at the head of an Hungarian army, who defeated the rebels, and restored to his kingdom a legitimate government. He had scarce reascended the throne when the united forces of the Russians, Tartars, and Lithuanians, made a second irruption into Poland, and desolated the country with the most savage barbarity. Their forces were now rendered more terrible than ever by their having along with them a vast number of large dogs trained to the art of war. Lechus, however, with an army much inferior, obtained a complete victory;

Poland. victory; the Poles being animated by despair, as perceiving, that, if they were conquered, they must also be devoured. Soon after this, Lechus died with the reputation of a warlike, wise, but unfortunate prince. As he died without issue, his crown was contested, a civil war again ensued; and the affairs of the state continued in a very declining way till the year 1296, when Premislaus, the duke at that time, resumed the title of *king*. However, they did not revive in any considerable degree till the year 1305, when Uladislaus Locticus, who had seized the throne in 1300, and afterwards been driven out, was again restored to it. The first transaction of his reign was a war with the Teutonic knights, who had usurped the greater part of Pomerania during the late disturbances. They had been settled in the territory of Culm by Conrade duke of Mazovia; but soon extended their dominion over the neighbouring provinces, and had even got possession of the city of Dantzic, where they massacred a number of Pomeranian gentlemen in cold blood; which so much terrified the neighbouring towns, that they submitted without a stroke. The knights were commanded by the Pope himself to renounce their conquests; but they set at nought all his thunders, and even suffered themselves to be excommunicated rather than part with them. As soon as this happened, the king marched into the territories of the marquis of Brandenburg, because he had pretended to sell a right to the Teutonic knights to those countries, when he had none to them himself. Uladislaus next entered the territory of Culm, where he laid every thing waste with fire and sword; and, being opposed by the joint forces of the marquis, the knights, and the duke of Mazovia, he obtained a complete victory after a desperate and bloody engagement. Without pursuing the blow, he returned to Poland, recruited his army, and being reinforced by a body of auxiliaries from Hungary and Lithuania, he dispersed the enemy's forces, and ravaged a second time all the dominions of the Teutonic order. Had he improved this advantage, he might easily have exterminated the whole order, or at least reduced them so low, that they could never have occasioned any more disturbances in the state; but he suffered himself to be soothed and cajoled by the promises which they made without any design of keeping them, and concluded a treaty under the mediation of the kings of Hungary and Bohemia. In a few months he was convinced of the perfidy of the knights; for they not only refused to evacuate Pomerania as had been stipulated in the treaty, but endeavoured to extend their usurpations, for which purpose they had assembled a very considerable army. Uladislaus, enraged at their treachery, took the field a third time, and gave them battle with such success, that 4000 knights were left dead on the spot, and 30,000 auxiliaries killed or taken prisoners. Yet, though the king had it once more in his power to destroy the whole Teutonic order, he satisfied himself with obtaining the territories which had occasioned the war; after which he spent the remainder of his life in peace and tranquillity.

61 War with the Teutonic knights.

62 Russia Nigra conquered by Casimir the Great.

Uladislaus was succeeded by his son Casimir III. surnamed the *Great*. He subdued the province called *Russia Nigra* in a single campaign. Next he turned his arms against Mazovia; and with the utmost rapidity over-ran the duchy, and annexed it as a province to the crown: after which he applied himself to domestic affairs, and was the first who introduced a written code of laws into Poland. He was the most impartial judge, the most rigid observer of justice, and the most submissive to the laws, of any potentate mentioned in the history of Europe. The only vice with which he is charged is that of incontinency; but even this the clergy declared to be a venial sin, and amply compensated by his other virtues, particularly the great liberality which he showed to the clerical order.

63 Unhappy reign of Louis.

Casimir was succeeded in 1370 by his nephew Louis king of Hungary; but, as the Poles looked upon him to be a foreign prince, they were not happy under his administration. Indeed a coldness between this monarch and his people took place even before he ascended the throne; for in the *pacta conventa*, to which the Polish monarchs were obliged to swear, a great number of unusual articles were inserted. This probably was the reason why he left Poland almost as soon as his coronation was over, carrying with him the crown, sceptre, globe, and sword of state, to prevent the Poles from electing another prince during his absence. He left the government in the hands of his mother Elizabeth; and she would have been agreeable to the people had her capacity for government been equal to the task. At that time, however, the state of Poland was too much distracted to be governed by a woman. The country was over-run with bold robbers and gangs of villains, who committed the most horrid disorders; the kingdom was likewise invaded by the Lithuanians; the whole province of Russia Nigra revolted; and the kingdom was universally filled with dissension. The Poles could not bear to see their towns filled with Hungarian garrisons; and therefore sent a message to the king, telling him that they thought he had been sufficiently honoured in being elected king of Poland himself, without suffering the kingdom to be governed by a woman and his Hungarian subjects. On this Louis immediately raised a numerous army, with a design fully to conquer the spirit of his subjects. His first operations were directed against the Russians; whom he defeated, and again reduced to subjection. Then he turned his arms against the Lithuanians, drove them out of the kingdom, and re-established public tranquillity. However, instead of being satisfied with this, and removing the Hungarian garrisons, he introduced many more, and raised Hungarians to all the chief posts of government. His credit and authority even went so far as to get a successor nominated who was disagreeable to the whole nation, namely *Sigismund* marquis of Brandenburg. After the death of Louis, however, this election was set aside; and Hedwiga, daughter of Casimir the Great, was proclaimed queen.

64 Hedwiga married duke of Lithuania, thereby uniting duchy, together with Samogitia and Russia Nigra, to Poland.

This princess married Jagello duke of Lithuania, who was now converted to Christianity, and baptized by the name of *Uladislaus*. In consequence of this marriage, the duchy of Lithuania, as well as the vast provinces of Samogitia and Russia Nigra, became annexed to the crown of Poland. Such a formidable accession of power excited the jealousy of the Teutonic knights, who were sensible that Uladislaus was now bound to undertake the reduction of Pomerania, and revenge all the injuries which Poland had sustained from them for a great number of years. From his first accession therefore they considered this monarch as their greatest enemy, and endeavoured to prevent his designs against them by effect-

Poland.

ing a revolution in Lithuania in favour of his brother Andrew. The proſpect of ſucceſs was the greater here, as moſt of the nobility were diſcontented with the late alliance, and Uladiſlaus had propoſed to effect a revolution in religion, which was highly diſagreeable. On a ſudden, therefore, two armies marched towards the frontiers of the duchy, which they as ſuddenly penetrated, laying waſte the whole country, and ſeizing upon ſome important fortreſſes before the king of Poland had any notice of the matter. As ſoon as he received advice of theſe ravages, Uladiſlaus raiſed ſome forces with the utmoſt celerity, which he committed to the care of his brother Skirgello, who defeated the Teutonic knights, and ſoon obliged them to abandon all their conqueſts. In the mean time Uladiſlaus marched in perſon into the Higher Poland, which was ſubjected to a variety of petty tyrants, who oppreſſed the people, and governed with intolerable deſpotiſm. The palatine of Poſnia in particular had diſtinguiſhed himſelf by his rebellious practices; but he was completely defeated by Uladiſlaus, and the whole country reduced to obedience.

65 Troubles in Lithuania.

Having ſecured the tranquillity of Poland, Uladiſlaus viſited Lithuania, attended by a great number of the clergy, in order to convert his ſubjects. This he effected without great difficulty; but left the care of the duchy to his brother Skirgello, a man of a cruel, haughty, and debauched turn, and who immediately began to abuſe his power. With him the king ſent his couſin Vitowda, a prince of a generous, brave, and amiable diſpoſition, to be a check upon his conduct; but the barbarity of Skirgello ſoon obliged this prince to take refuge among the Teutonic knights, who were now become the aſylum of the oppreſſed and diſcontented. For ſome time, however, he did not aſſiſt the knights in their deſigns againſt his country; but having applied for protection to the king, and finding him remiſs in affording the neceſſary aſſiſtance, he at laſt joined in the ſchemes formed by the knights for the deſtruction of Poland. Entering Lithuania at the head of a numerous army, he took the capital, burnt part of it, and deſtroyed 14,000 perſons in the flames, beſides a great number who were maſſacred in attempting to make their eſcape. The upper part of the city, however, was vigorouſly defended, ſo that the beſiegers were at laſt obliged to abandon all thoughts of making themſelves maſters of it, and to content themſelves with deſolating the adjacent country. The next year Vitowda renewed his attempts upon this city, but with the ſame ill ſucceſs; though he got poſſeſſion of ſome places of leſs note. As ſoon, however, as an opportunity offered, he came to an accommodation with the king, who beſtowed on him the government of Lithuania. During the firſt years of his government, he beſtowed the moſt diligent attention upon domeſtic affairs, endeavouring to repair the calamities which the late wars had occaſioned; but his impetuous valour prompted him at laſt to engage in a war with Tamerlane the Great, after his victory over Bajazet the Turkiſh emperor. For ſome time before, Vitowda had been at war with the neighbouring Tartars, and had been conſtantly victorious, tranſporting whole hordes of that barbarous people into Poland and Lithuania, where to this day they form a colony diſtinct in manners and dreſs from the other inhabitants. Uladiſlaus, however, diſſuaded him from attacking the whole ſtrength of the nation under ſuch a celebrated commander as Tamerlane: but Vitowda was obſtinate; he encountered an army of 400,000 Tartars under Ediga, Tamerlane's lieutenant, with only a tenth part of their number. The battle continued for a whole day; but at laſt Vitowda was ſurrounded by the numbers of his enemy, and in the utmoſt danger of being cut in pieces. However, he broke his way through with prodigious ſlaughter on both ſides; and came off at laſt without a total defeat, having killed a number of the enemy equal to the whole of his own army.

66 Terrible battle with the Tartars.

67 Wars with the Teutonic knights.

During the abſence of Vitowda, the Teutonic knights had penetrated into Lithuania, committing everywhere the moſt dreadful ravages. On his return he attacked and defeated them, making an irruption into Livonia, to puniſh the inhabitants of that country for the aſſiſtance they had given to the Teutonic order. This was ſucceeded by a long ſeries of wars between Poland and Pruſſia, in which it became neceſſary for Uladiſlaus himſelf to take the field. The knights had now one way or other got poſſeſſion of Samogitia, Mazovia, Culm, Sileſia, and Pomerania; ſo that Uladiſlaus reſolved to puniſh them before they became too powerful. With this view he aſſembled an army compoſed of ſeveral different nations, with which he penetrated into Pruſſia, took ſeveral towns, and was advancing to Marienburg the capital of Pomerania, when he was met by the army of the Pruſſian knights, who determined to hazard a battle. When the engagement began, the Poles were deſerted by all their auxiliaries, and obliged to ſtand the brunt of the battle by themſelves. But the courage and conduct of their king ſo animated them, that after a moſt deſperate battle they obtained a complete victory; near 40,000 of the enemy being killed in the field, and 30,000 taken priſoners. This terrible overthrow, however, was leſs fatal to the affairs of the Pruſſian knights than might have been expected; as Uladiſlaus did not improve his victory, and a peace was concluded upon eaſier terms than his adverſaries had any reaſon to expect.—Some infraction of the treaty occaſioned a renewal of hoſtilities; and Uladiſlaus was ſo much elated with victory that he would hearken to no terms, by which means the enemy were driven to the deſperate reſolution of burying themſelves in the ruins of their capital. The ſiege was accordingly commenced, and both ſides behaved with the greateſt vigour; but at laſt, through the good conduct and valour of the grand maſter of the knights named *Plawen*, the Poliſh monarch found himſelf obliged to grant them an advantageous peace, at a time when it was univerſally expected that the whole order would have been exterminated.

Uladiſlaus V. died in 1435, and was ſucceeded by his ſon Uladiſlaus VI. at that time only nine years of age. He had ſcarce aſcended the throne, when the kingdom was invaded by the Tartars, who defeated Buccarius the general of the Poliſh forces; and committing everywhere dreadful ravages, returned to their own country loaded with booty. A few years after, the nation was involved in a war with Amurath the emperor of the Turks, who threatened to break into Hungary; and it was thought by the diet to be good policy to aſſiſt the Hungarians at this juncture, becauſe it was impoſſible to know where the ſtorm might

fall

Poland. fall after Hungary was conquered. But before all things were prepared for the young king to take the field, a strong body of auxiliaries were dispatched under the celebrated John Hunniades vaivode of Transylvania, to oppose the Turks, and likewise to support the election of Uladislaus to the crown of Hungary. This detachment surprised the Turkish army near the river Morava, and defeated Amurath with the loss of 30,000 men; after which Hunniades retook all the places which had been conquered by Amurath, the proud sultan was forced to sue for peace, and Uladislaus was raised without opposition to the crown of Hungary. A treaty was concluded, by which the Turks promised to relinquish their designs upon Hungary, to acknowledge the king's right to that crown, and to give up all their conquests in Rascia and Servia. This treaty was sealed by mutual oaths: but Uladislaus broke it at the persuasion of the pope's legate; who insisted, that now was the time for humbling the power of the infidels; and produced a special commission from the pope, absolving him from the oath he had taken at the late treaty. The consequence of this perfidy was, that Uladislaus was entirely defeated and killed at Varna, and the greatest part of his army cut in pieces.

68 Uladislaus defeated and killed by the Turks.

Uladislaus VI. was succeeded by Casimir IV. in whose reign the Teutonic knights were subdued, and obliged to yield up the territories of Culm, Michlow, and the whole duchy of Pomerania, together with the towns of Elbing, Marienburg, Talkmith, Schut, and Christburgh, to the crown of Poland. On the other hand, the king restored to them all the other conquests he had made in Prussia, granted a seat in the Polish senate to the grand-master, and endowed him with other privileges, on condition that, six months after his accession, he should do homage for Prussia, and take an oath of fidelity to the king and republic.

69 Teutonic knights subdued.

This success raised the spirits of the Polish nation, which had drooped ever since the battle of Varna. The diet did not, however, think proper to renew the war against the Turks, but took under their protection the hospodar of Moldavia; as thinking that this province would make a convenient barrier to the Polish dominions on one side. The request of the prince who asked this protection was therefore readily granted, an oath of fidelity exacted from him and the inhabitants, and a tribute required; regular payment of which was made for a great number of years afterwards.

70 Crowns of Bohemia and Hungary united to Poland.

About this time also the crown of Bohemia becoming vacant, the people were extremely desirous of being governed by one of the princes of Poland; upon which the barons were induced to bestow the crown upon Uladislaus, eldest son of Casimir, in opposition to the intrigues of the king of Hungary. Not satisfied with this acquisition, Uladislaus took advantage of the dissensions in Hungary, in order to unite that crown to his own: and this he also effected; by which means his power was greatly augmented, though not the felicity of his people. So many foreign expeditions had exhausted the treasury, and oppressed the peasants with taxes; the gentry were greatly diminished by a number of bloody engagements; agriculture was neglected, and the country almost depopulated. Before a proper remedy could be applied for these evils, Casimir died in 1492; much more admired, than beloved or regretted, by his subjects. It is related by the historians of this period, that in the reign of Casimir IV. the deputies of the provinces first appeared at the diet, and assumed to themselves the legislative power; all laws before this time having been framed by the king in conjunction with the senate. It is observed also, that before Casimir's time, the Latin language was understood only by the clergy of Poland; in proof of which, it is alleged, that at an interview between this prince and the king of Sweden at Dantzick, his Polish majesty was forced to make use of the assistance of a monk to interpret between him and the Swedish monarch. Casimir, ashamed of the ignorance shown by himself and court, published an edict, enjoining the diligent study of the Latin, which in our days is spoken as vernacular by every Polish gentleman, though very unclassically.

During the succeeding reigns of John, Albert, and Alexander, the Polish affairs fell into decline; the kingdom being harassed by continual wars with the Turks and Tartars. However, they were retrieved by Sigismund I. who ascended the throne in 1507. This monarch, having reformed some internal abuses, next set about rendering the kingdom as formidable as it had formerly been. He first quelled a rebellion which broke out in Lithuania; after which, he drove the Walachians and Moldavians out of Russia Nigra, and defeated the Russians in a pitched battle, with the loss of 30,000 men. In this engagement he was obliged to cause his cavalry to swim across the Boristhenes in order to begin the attack, while a bridge was preparing for the infantry. These orders were executed with astonishing celerity, notwithstanding the rapidity of the stream, the steepness of the banks, and the enemy's opposition. The onset was led by the Lithuanians, who were directed to retreat gradually, with a view of drawing the enemy within reach of the cannon. This the Russians mistook for a real flight; and as they were pursuing with eagerness, Sigismund opened his line to the right and left, pouring in grape-shot from the artillery with dreadful success. The Russian general, and several noblemen of the first distinction, were taken prisoners, while the whole loss of the royal army did not amount to 300 men.

Exp[...] Sig[...] I.

After this complete victory, the king turned his arms against the Teutonic knights, who had elected the marquis of Brandenburgh their grand-master; and this prince not only refused to acknowledge the sovereignty of the crown of Poland, but even invaded the Polish territories. Sigismund marched against him, and gained possession of several important places in Brandenburgh; but as he was pursuing his conquests, the marquis was reinforced by 14,000 Germans, led by the duke of Schonenburg, who ventured to lay siege to Dantzic, after having ravaged all the neighbouring country. The Dantzickers, however, defended themselves with so much spirit, that the besiegers were soon obliged to relinquish their enterprise. In their retreat they were attacked by a strong detachment of Polish cavalry, who made prodigious havock among them, and compelled the wretched remains to take shelter in Pomerania, where they were inhumanly butchered by the peasants. Soon after this the marquis was obliged to submit to the clemency of the conqueror; from whom, however, he obtained better conditions than could have been expected, or indeed than he would

Poland.

would have got, had he not abandoned the intereſt of the Teutonic order, and reſigned the dignity of grand-maſter. In order to ſecure him in his intereſt, therefore, Sigiſmund granted him half the province of Pruſſia as a ſecular duke, and dependent on the crown of Poland; by which means he entirely deprived that order of the beſt part of their dominions, and put it quite out of their power to diſturb the tranquillity of Poland any more.

The power of Sigiſmund had now excited the jealouſy of the Houſe of Auſtria; for which reaſon they took every method in their power to ſtir up enemies againſt him. By their means, the Ruſſians, Moldavians, and Tartars, were all excited to fall upon the Poliſh territories at once. The vaivode of Walachia, with 50,000 men, made an irruption into the ſmall province of Pokatior, but was entirely defeated by count Taro at the head of no more than 6000. This victory is wholly aſcribed to the good conduct of the commander, who poſſeſſed himſelf of ſome eminences on the flanks of the enemy. On theſe he erected batteries; which played with ſuch fury as ſoon put their ranks in diſorder: upon which the Poles attacked them ſword in hand, and entirely diſperſed them with the loſs of 10,000 killed or taken. The count having then augmented his army with a ſtrong body of Lithuanians, attacked the Muſcovites and Tartars, drove them entirely out of the duchy, purſued them into Ruſſia, reduced ſeveral towns, and at laſt ſaid ſiege to the ſtrong fortreſs of Straradub; in which the regent, together with ſome of the beſt troops of Ruſſia, were incloſed. The garriſon made a gallant defence; and the fortifications were compoſed of beams joined together, and ſupported by a bulwark of earth, upon which the cannon-ſhot made no impreſſion: but the count contrived a method of ſetting the wood on fire; by which means the regent and nobility were obliged to ſurrender at diſcretion, and Taro carried off upwards of 60,000 priſoners, with an immenſe booty.

In the reign of Sigiſmund, we may look upon the kingdom of Poland to have been at its greateſt pitch of glory. This monarch poſſeſſed, in his own perſon, the republic of Poland, the great duchies of Lithuania, Smolenſko, and Saveria, beſides vaſt territories lying beyond the Euxine and Baltic; while his nephew Lewis poſſeſſed the kingdoms of Bohemia, Hungary, and Sileſia. But this glory received a ſudden check in 1548, by the defeat and death of Louis, who periſhed in a battle fought with Solyman the Great, emperor of the Turks. The daughter of this prince married Ferdinand of Auſtria; whereby the dominions of Hungary, Bohemia, and Sileſia, became inſeparably connected with the hereditary dominions of the Auſtrian family. This misfortune is thought to have haſtened the death of Sigiſmund; though, being then in his 84th year, he could not have lived long by the ordinary courſe of nature. He did not, however, ſurvive the news many months, but died of a lingering diſorder, leaving behind him the character of the completeſt general, the ableſt politician, the beſt prince, and the ſtrongeſt man, in the north; of which laſt, indeed, ſome inſtances are related by hiſtorians that are almoſt incredible.

Sigiſmund Auguſtus, who ſucceeded his father Sigiſmund I. proved alſo a very great and happy prince. At that time the moſt violent and bloody wars were carrying on in Germany, and indeed through other parts of Europe, on account of religion; but Sigiſmund wiſely avoided interfering in theſe diſputes. He would not admit into his dominions any of thoſe divines who were taxed with holding heterodox opinions, nor even allow his people the liberty of correſponding with them; yet he never perſecuted, or employed any other means for the preſervation of the ſtate than thoſe of a well-conducted and regular policy. Inſtead of diſputing with his ſubjects about ſpeculative opinions, Sigiſmund applied himſelf diligently to the reforming of abuſes, enforcing the laws, enriching the treaſury, promoting induſtry, and redeeming the crown-lands where the titles of the poſſeſſors appeared illegal. Out of the revenue recovered in this manner he obtained a formidable ſtanding army, without laying any additional tax upon the ſubjects; and though he preferred peace to war, he was always able to puniſh thoſe that offered indignities to his crown or perſon. His knowledge in the art of war was ſoon tried in a conteſt with the Ruſſians, who had made an irruption into Livonia, encouraged by the diſputes which had ſubſiſted between the Teutonic knights and the archbiſhop of Riga, couſin to Sigiſmund. The province was at that time divided between the knights and the prelate; and the Ruſſians, under pretence of aſſiſting the former, had ſeized great part of the dominions of the latter. The archbiſhop had recourſe to his kinſman the king of Poland; who, after fruitleſs efforts to accommodate matters, marched towards the frontiers of Livonia with an army of 100,000 men. The knights were by no means able to reſiſt ſuch a formidable power; and therefore, deſerting their late allies, put themſelves under the protection of the king of Poland. The czar, John Baſilides, though deſerted by the knights, did not loſe his courage; nay, he even inſolently refuſed to return any anſwer to the propoſals of peace made by Sigiſmund. His army conſiſted of 300,000 men, with whom he imagined himſelf able to reduce all Livonia, in ſpite of the utmoſt efforts of the king of Poland: however, having met with ſome checks on that quarter, he directly invaded Poland with his whole army. At firſt he carried every thing before him; but the Poles ſoon made a vigorous oppoſition. Yet the Ruſſians, though everywhere defeated, ſtill continued their incurſions, which Sigiſmund at laſt revenged by invading Ruſſia in his turn. Theſe mutual deſolations and ravages at laſt made both parties deſirous of peace, and a truce for three years was agreed on; during the continuance of which the king of Poland died, and with him was extinguiſhed the houſe of Jagellon, which had governed Poland for near 200 years.

72 Sigiſmund Auguſtus, a wiſe and valiant prince.

73 War with Ruſſia.

74 Extinction of the houſe of Jagellon.

On the death of Sigiſmund, Poland became a prey to inteſtine diviſions; and a vaſt number of intrigues were ſet on foot at the courts of Vienna, France, Saxony, Sweden, and Brandenburgh; each endeavouring to eſtabliſh a prince of their own nation on the throne of Poland. The conſequence of all this was, that the kingdom became one univerſal ſcene of corruption, faction, and confuſion; the members of the diet conſulted only their own intereſt, and were ready on every occaſion to ſell themſelves to the beſt bidder. The Proteſtants had by this time got a conſiderable footing in the kingdom, and thus religious diſputes were intermingled

75 Diſtracted ſtate of Poland.

Poland.

termingled with political ones. One good effect, however, flowed from this confusion: for a law was passed, by which it was enacted, that no difference in religious opinions should make any contention among the subjects of the kingdom; and that all the Poles, without discrimination, should be capable of holding public offices and trusts under the government; and it was also resolved, that the future kings should swear expressly to cultivate the internal tranquillity of the realm, and cherish without distinction their subjects of all persuasions.

While the candidates for the throne were severally attempting to support their own interest in the best manner they could, John Crasoski, a Polish gentleman of great merit, but diminutive stature, had just returned from France, whither he had travelled for improvement. His humour, wit, and diverting size, had rendered him universally agreeable at the court of France, and in a particular manner engaged the esteem of Catharine de Medicis, which the little Pole had the address to make use of for his own advantage. He owed many obligations to the duke of Anjou; whom, out of gratitude, he represented in such favourable terms, that the Poles began to entertain thoughts of making him their king. These sentiments were confirmed and encouraged by Crasoski, who returned into France by order of several leading men in Poland, and acquainted the king and queen Catharine, that nothing was wanting besides the formality of an embassy to procure the crown for the duke of Anjou, almost without opposition. Charles IX. king of France, at that time also promoted the scheme, being jealous of the duke of Anjou's popularity, and willing to have him removed to as great a distance as possible. Accordingly the parties came to an agreement; and it was stipulated that

76 Duke of Anjou chosen king of Poland.

the duke of Anjou should maintain the laws, liberties, and customs of the kingdom of Poland, and of the grand duchy of Lithuania; that he should transport all his effects and annual revenues in France into Poland; that the French monarch should pay the late king Sigismund's debts; that he should maintain 100 young Polish gentlemen at his court; and 50 in other places; that he should send a fleet to the Baltic, to assist Poland against the Russians; and lastly, that Henry should marry the princess Anne, sister to the late king Sigismund; but this article Henry would not ratify till his return to Poland.

Every thing being thus settled, the young king quitted France, attended by a splendid retinue, and was accompanied by the queen-mother as far as Lorrain. He was received by his subjects on the frontiers of Poland, and conducted to Cracow, where he was soon after crowned. The affections of the Poles were soon engaged by the youth and accomplishments of Henry; but scarce was he seated on the throne, when, by the death of Charles IX. he became heir to the crown of France. Of this he was informed by repeated messages from queen Catharine; he repented his having accepted the crown of Poland, and resolved to leave it

77 Runs away from his kingdom,

for that of France. But being sensible that the Poles would oppose his departure, he kept his intentions secret, and watched an opportunity of stealing out of the palace in disguise in the night-time. The Poles, as might well have been expected, were irritated at being thus abandoned, from the mere motive of interest, by a prince whom they had loved and honoured so much. Parties were dispatched after him by different roads; and Zamoski, a nobleman who headed one of these parties, overtook him some leagues distant from Cracow. All the prayers and tears of that nobleman, however, could not prevail on Henry to return; he rode post to Vienna, and then passed into France by the way of Italy.

In the mean time, the Poles were so much exasperated against Henry and his whole nation, that all the French in Cracow would have been massacred if the magistrates had not placed guards in the streets. Henry, however, had foreseen the consequences of his flight, and therefore endeavoured to apologise for his behaviour. One Danzai undertook his cause in full senate; and with great eloquence explained the king's motives for his abrupt departure. Henry also wrote to the chief nobility and clergy with his own hand. But nothing could satisfy the Poles; who now acquainted their king, that if he did not immediately return, they would be obliged to divest him of the royal dignity, and to choose another sovereign. Henry began to excuse himself on account of the wars in which he was engaged, and promised to send men of unexceptionable integrity to govern Poland till he should return: but no excuses could be accepted; and, on the 15th of July 1575, he was solemnly divested of the regal dignity in full diet, and the throne declared vacant. 78 And is deposed.

After the deposition of Henry, commotions and factions again took place. However, the contending parties were now reduced to two; one who supported the interest of Maximilian emperor of Germany; the other, who were for electing the princess Anne, and marrying her to Stephen Batori prince of Transylvania. The latter prevailed through the courage of one gentleman, who, in imitation of the power assumed by the Roman tribunes, stood up in the full senate, and opposed the proclamation of Maximilian, declaring that his election was violent and illegal. In this situation of affairs, it was obvious that strength and celerity must determine which election was legitimate: both parties wrote to the princes whose cause they had espoused, intreating them to come with all possible expedition to take possession of the throne. Batori proved the more alert; for while Maximilian was disputing about certain conditions which the Poles required for the security of their privileges, he entered Poland, married the princess, and was crowned on the first of May 1576. 79 Stephen Batori chosen king.

No opposition was made to the authority of Batori except by the inhabitants of Dantzic. These adhered to the interest of Maximilian even after he was dead, and had the presumption to demand from the king an oath acknowledging their absolute freedom and independence. Batori referred them to the senate, declaring that he had no right to give up the privileges of the republic; but admonished the citizens to avoid all occasion of a civil war, which must necessarily terminate in their disadvantage. But the obstinate citizens, construing the king's lenity into fear, shut the gates against the ambassador, seized upon the fortress of Grebin, and published a manifesto resembling a libel upon the king and the republic. The king, incensed at these proceedings, marched against Grebin, retook the castle, and ravaged certain territories belonging 80 Dantzic revolts.

land. longing to the Dantzickers; who retaliated by burning to the ground a monastery named *Oliva*, to prevent the Poles from taking possession of so important a situation.

Notwithstanding these outrages, Batori renewed his overtures for an accommodation: but the Dantzickers were deaf to these salutary proposals; so that he was obliged to declare them rebels, and send against them a body of troops under one Zborowski. As the number of the Polish army, however, was not considerable, the Dantzickers marched out to give him battle. They were assisted by a corps of Germans, and a resolution was formed of attacking the Poles in their camp by surprise; but the project was disconcerted by a sudden storm, accompanied with dreadful thunder and lightning, which spread a panic through the army, as if it had been a judgment from heaven, and obliged the commander, John de Collen, to retire into the city. In a short time, however, they recovered their spirits, and came to an action with the Poles; but were defeated with the loss of 8000 men killed on the spot, a great many taken prisoners, and the loss of several pieces of cannon. But this check, instead of abating the courage of the Dantzickers, only animated them the more, and they resolved to hold out to the last extremity.

81
nd in-
d by
Ruf-

In the mean time, the czar of Muscovy, thinking the present opportunity favourable for extending his dominions, laid siege to Revel; but, not being able to make himself master of that place, he was obliged to content himself with ravaging Livonia, which he did in a dreadful manner. This did not, however, hinder Batori from laying siege to Dantzic in person, and pursuing the operations with the utmost vigour. Collen made many vigorous sallies, in several of which he defeated the Poles; but happening at last to be killed, nobody was found capable of supplying his place, and the citizens were at last obliged to surrender at discretion;

82
tzic
nts.

though not till they had obtained a promise from the elector of Saxony and landgrave of Hesse of interposing as mediators in their behalf. The only terms which the king demanded of them were, that they should ask his pardon, dismiss their troops, and rebuild the monastery of Oliva which they had destroyed; while his majesty, on the other hand, confirmed all their privileges, and granted them full liberty of adhering to the confession of Augsburg, for which they had for some time been strenuous advocates.

83
elty of
Ruf-

The war with Dantzic was no sooner ended, than the king directed his whole strength against the czar of Muscovy, who had made himself master of several important cities in Livonia. The czar behaved every where with the greatest cruelty, slaughtering all without distinction who were able to bear arms, and abandoning the women and children to the shocking brutality of the Tartars who served in his army. Such was the horror inspired by the perfidy and cruelty of the czar's conduct, that the inhabitants of Wender chose rather to bury themselves in the ruins of their town than to submit to such an inhuman enemy. For a considerable time the Russians were allowed to proceed in this manner, till the whole province of Livonia, excepting Riga and Revel, had suffered the barbarities of this insulting conqueror; but at last, in 1578, a body of forces was dispatched into the province, the towns of Wender and Dunnenburg were surprised, and an army sent by the czar to surprise the former was defeated. Poland.

At this time the Muscovites were not the only enemies who opposed the king of Poland, and oppressed Livonia. That unhappy province was also invaded by the Swedes, who professed themselves to be enemies equally to both parties, and who were scarce inferior in cruelty to the Russians themselves. The king, however, was not daunted by the number of his adversaries; but having made great preparations, and called to his assistance Christopher prince of Transylvania, with all the standing forces of that country, he took the field in person against the Muscovites, and laid siege to Polocz, a town of great importance situated on the river Dwina. 84

Siege of Polocz.

The Russians no sooner heard of the approach of the Polish army, than they resolved to put all the citizens to death, thinking by this means to strike terror into the enemy. When Batori came near the town, the most shocking spectacle presented itself; the river appeared dyed with blood, and a vast number of human bodies fastened to planks, and terribly mangled, were carried down its stream. This barbarity, instead of intimidating the Poles, irritated them to such a degree, that nothing could resist them. Finding that their cannon made little impression upon the walls of the city, which were constructed of wood, they advanced to the assault with burning torches in their hands; and would soon have reduced the fortifications to ashes, had not a violent storm of rain prevented them. The design, however, was put in execution as soon as the rain slackened; and the barbarous Russians were obliged to surrender at discretion. It reflects the highest honour on Batori, that, notwithstanding the dreadful instances of cruelty which he had before his eyes, he would not suffer his soldiers to retaliate. Indeed the cruelties committed by the Russians on this occasion, 85

Monstrous barbarities committed by the Russians in that city.

seem almost to have authorised any revenge that could possibly have been taken. A number of Germans were found in the city, some expiring under the most dreadful tortures, and others dead of pains which nature could no longer support. Several of the officers had been dipped in cauldrons of boiling oil, with a cord drawn under the skin of the umbilical region, which fastened their hands behind; in which situation their eyes had been torn out from their sockets, or burnt with red-hot irons, and their faces otherwise terribly mangled. The disfigured carcases, indeed, plainly showed the barbarous treatment they had met with; and the dreadful tale was confirmed by the testimony of the few who survived. The Polish soldiers were exasperated almost to madness; so that scarce all the authority of Batori could restrain them from cutting in pieces the wretches who had been the authors of such a dreadful tragedy. 86

Russia ravaged by Batori.

After the reduction of Polocz, Batori continued the war with great success. Two detachments from the army penetrated the enemy's country by different roads, wasted all before them to the gates of Smolensko, and returned with the spoils of 2000 villages which they had pillaged and destroyed. In the mean time the Swedes and Poles thought proper to come to an accommodation: and though John king of Sweden was at that time prevented from bearing his share of the war, yet Batori reduced such a number of cities, and committed such

Poland.

87 The Czar sues for peace.

such devastations in the Russian territories, that the czar was obliged to sue for peace; which he obtained on condition of relinquishing Livonia, after having thrown away the lives of more than 400,000 of his subjects in attempting to conquer it.

Batori, being thus freed from a most destructive and cruel war, applied himself to the internal government of his kingdom. He regulated the Polish cavalry in such a manner as made them become formidable to the Turks and other neighbouring nations: and this is the military establishment to which the Poles have given the name of *quartienne;* because a fourth part of the revenue is employed in supporting them. Batori sent this body of cavalry towards the frontiers of Tartary, to check the incursions of those barbarians; by which means the Ukraine, a vast tract of desert country, was filled with flourishing towns and villages, and became a strong barrier against the Turks, Tartars, and Russians.

88 Batori civilizes the Cossacks.

The last memorable action of Batori was his attaching the Cossacks to Poland, civilizing and instructing them in the arts of war and peace. His first endeavour was to gain their affections by his liberality; for which purpose, he presented them with the city of Techtemeravia, situated on the Boristhenes, which they formed into a magazine, and made the residence of their chieftains. He gave them officers of all degrees, established discipline among them, altered their arms, and formed them into a regular militia, which afterwards performed eminent services to the state. All kinds of manufactures at that time known in Poland were likewise established among the Cossacks; the women were employed in spinning and weaving woollen cloths, while the men were taught agriculture, and other arts proper for their sex.

While Batori was employed in this manner, the Swedes broke the convention into which they had entered with Poland, and were on the point of getting possession of Riga. To this, indeed, Batori himself had given occasion, by attempting to impose the Romish religion upon the inhabitants, after having promised them entire liberty of conscience. This so irritated them, that they revolted, and were on the point of admitting a Swedish garrison into the city, when the king was informed of what was going forward. Upon this he resolved to take a most exemplary vengeance on the inhabitants of Riga; but before he could execute his intention, he died in the year 1586, the 54th of his age, and 10th of his reign.

89 His death.

The death of Batori involved Poland in fresh troubles. Four candidates appeared for the crown, viz. the princes Ernest and Maximilian of the house of Austria; Sigismund prince of Sweden, and Theodore czar of Muscovy. Each of these had a separate party; but Sigismund and Maximilian managed matters so well, that in 1587 both of them were elected. The consequence of this was a civil war; in which Maximilian was defeated and taken prisoner: and thus Sigismund III. surnamed *De Vasa*, became master of the throne of Poland without opposition. He waged a successful war with the Tartars, and was otherwise prosperous; but though he succeeded to the crown of Sweden, he found it impossible for him to retain both kingdoms, and he was formally deposed from the Swedish throne. In 1610 he conquered Russia, and placed his son on the throne; but the Polish conquests of that country have always been but for a short time. Accordingly the young prince was soon after deposed; and the Russians not only regained their liberty, but began to make encroachments on Poland itself. A very unfortunate war also took place with Sweden, which was now governed by the great Gustavus Adolphus; the particulars of which, with the other exploits of that renowned warrior, are related under the article SWEDEN. At last Sigismund, worn out with cares and misfortunes, died in 1629.

Poland

90 War with Gustavus Adolphus.

After Sigismund's death the affairs of Poland seemed to revive a little under Uladislaus VII.; for he obliged the Russians to sue for peace, and Sweden to restore some of her conquests: but having attempted to abridge the liberty of the Cossacks, they revolted, and gave the Poles several terrible defeats. Nor was the war terminated in the lifetime of Uladislaus, who died in 1648. His successor, John Casimir, concluded a peace with these dangerous enemies: but the war was soon after renewed; and while the kingdom was distracted between these enemies and the discontents of its own inhabitants, the Russians took the opportunity of invading and pillaging Lithuania. In a little after the whole kingdom was subdued by Charles Gustavus, successor to Christina queen of Sweden.

91 Poland subdued by Charles Gustavus.

Happily for Poland, however, a rupture took place between the courts of Sweden and Copenhagen; by which means the Poles were enabled to drive out the Swedes in 1657. This was succeeded by civil wars and contests with Russia, which so much vexed the king, that he resigned the crown in 1668.

For two years after the resignation of Casimir the kingdom was filled with confusion; but on the 17th of September 1670, one Michael Coribut Wiesnowiski, collaterally descended from the house of Jagello, but in a very mean situation at that time, was chosen king. His reign continued but for three years; during which time John Sobieski, a celebrated Polish general, gave the Turks a dreadful overthrow, though their army consisted of more then 300,000 men; and had this blow been pursued, the Cossacks would have been entirely subdued, and very advantageous terms might have been obtained from the sultan. Of that vast multitude of Turks no more than 15,000 made their escape, the rest being all either killed or taken: however, the Polish soldiers, being bound by the laws of their country only to stay a certain time in the field, they refused to pursue this signal victory, and suffered the king to make peace on any terms he could procure.

92 John Sobieski retrieves the Polish affairs.

Wiesnowiski died before the news of this transaction reached Cracow; and after his death a new scene of confusion ensued, till at last the fortune of John Sobieski prevailed, and he was elected king of Poland in 1674. He was a most magnanimous and heroic prince; who, by his valour and good conduct, retrieved the affairs of Poland, and entirely checked the progress of the Turks westward. These barbarians were everywhere defeated, as is particularly related under the article TURKY; but notwithstanding his great qualities, Poland was now so thoroughly corrupted, and pervaded by a spirit of disaffection, that the latter part of this monarch's reign was involved in troubles, through the ambition and contention of some powerful noblemen.

Sobieski died in 1696; and with him fell the glory of Poland. Most violent contests took place about the succession; the recital of which would far exceed our limits.

limits. At laſt Frederic Auguſtus, elector of Saxony, prevailed; but yet, as ſome of the moſt eſſential ceremonies were wanting in his coronation, becauſe the primate, who was in an oppoſite intereſt, would not perform them, he found it extremely difficult to keep his ſubjects in proper obedience. To add to his misfortunes, having engaged in a league with Denmark and Ruſſia againſt Sweden, he was attacked with irreſiſtible fury by Charles XII. Though Auguſtus had not been betrayed, as indeed he almoſt always was, he was by no means a match for the ferocious Swede. The particulars of this war, however, as they make great part of the exploits of that northern hero, more properly fall to be related under the article SWEDEN. Here, therefore, we ſhall only obſerve, that Auguſtus was reduced to the humiliating neceſſity of renouncing the crown of Poland on oath, and even of congratulating his rival Staniſlaus upon his acceſſion to the throne: but when the power of Charles was broken by his defeat at Pultowa, the fortune of Auguſtus again prevailed; Staniſlaus was driven out; and the former being abſolved from his oath by the pope, reſumed the throne of Poland.

94 ...neracy ...

Since that time the Poliſh nation hath never made any figure. Surrounded by great and ambitious powers, it hath ſunk under the degeneracy of its inhabitants; ſo that it now ſcarce exiſts as a nation. This cataſtrophe took place in the following manner: On the 5th of October 1763, died Auguſtus III. elector of Saxony, and king of Poland. He was ſucceeded by Count Poniatowſki, a Poliſh grandee, who was proclaimed September 7th 1764, by the name of *Staniſlaus Auguſtus*, and crowned on the 25th of November the ſame year.—During the interregnum which took place between the death of Auguſtus III. and the election of Staniſlaus, a decree had been made by the convocation-diet of Poland, with regard to the *diſſidents*, as they were called, or diſſenters from the Popiſh religion. By this decree they were prohibited from the free exerciſe of their religion, much more than they had formerly been, and totally excluded from all poſts and places under the government. On this ſeveral of the European powers interpoſed, at the application of the diſſidents, for their good offices. The courts of Ruſſia, Pruſſia, Great Britain, and Denmark, made remonſtrances to the diet; but, notwithſtanding theſe remonſtrances, the decree was confirmed by the coronation-diet held after the king's election.

95 ...tion ...nia-...ki, by ...ame ...niſ- Auguſ. ...o the ...e.

96 ...fe- ...of fo- ...ers in ...f of ...iſſi- ...s.

October 6. 1766, an ordinary diet was aſſembled. Here declarations from the courts above mentioned were preſented to his Poliſh majeſty, requiring the re-eſtabliſhment of the diſſidents in their civil rights and privileges, and the peaceable enjoyment of their modes of worſhip ſecured to them by the laws of the kingdom which had been obſerved for two centuries. Theſe privileges, it was alleged, had been confirmed by the treaty of Oliva, concluded by all the northern powers, which could not be altered but by the conſent of all the contracting parties. The Popiſh party contended ſtrongly for a confirmation of ſome decrees made againſt the diſſidents in 1717, 1723, and 1736. The deputies from the foreign powers replied, that thoſe decrees had paſſed in the midſt of inteſtine troubles, and were contradicted by the formal proteſtations and expreſs declarations of foreign powers. At laſt, after violent conteſts, the matter was referred to the biſhops and ſenators for their opinion. Upon a report from them, the diet came to a reſolution, That they would fully maintain the diſſidents in all the rights and prerogatives to which they were intitled by the laws of their country, particularly by the conſtitutions of the year 1717, &c. and by treaties; and that as to their complaints with regard to the exerciſe of their religion, the college of archbiſhops and biſhops, under the direction of the prince primate, would endeavour to remove thoſe difficulties in a manner conformable to juſtice and neighbourly love.—By this time, however, the court of Ruſſia ſeemed determined to make her remonſtrances more effectual, and a ſmall body of Ruſſian troops marched to within two miles of the capital of Poland.

Theſe reſolutions of the diet were by no means agreeable to the diſſidents. They dated the beginning of their ſufferings from the year 1717. The referring their grievances to the archbiſhops and biſhops was looked upon as a meaſure the moſt unreaſonable that could be imagined, as that body of men had always been their oppoſers, and in fact the authors of all the evils which had befallen them.—Shortly after matters were conſidered in this view, an additional body of Ruſſians, to the number of about 15,000, entered Poland.

97 Conſequences of this.

The diſſidents, being now pretty ſure of the protection of foreign powers, entered, on the 20th of March 1767, into two confederacies, at Thorn and Sluck. One of them was ſigned by the diſſidents of Great and Little Poland, and the other by thoſe of the Great Duchy of Lithuania. The purport of theſe confederacies was, an engagement to exert themſelves in the defence of their ancient privileges, and the free exerciſe of their religion; profeſſing, at the ſame time, however, the utmoſt loyalty to the king, and reſolving to ſend a deputation to him to implore his protection. They even invited thoſe of the Catholic communion, and all true patriots, to unite with them in maintaining the fundamental laws of the kingdom, the peace of religion, and the right of each one jointly with themſelves. They claimed, by virtue of public treaties, the protection of the powers who were guarantees of their rights and liberties; namely, the empreſs of Ruſſia, and the kings of Sweden, Great Britain, Denmark, and Pruſſia. Laſtly, they proteſted, that they had no intention of acting to the detriment of the Roman Catholic religion, which they duly reſpected; and only aſked the liberty of their own, and the re-eſtabliſhment of their ancient rights. The three cities of Thorn, Elbing, and Dantzic, acceded to the confederacy of Thorn on the 10th of April; as did the duke and nobles of Courland to that of Sluck on the 15th of May.

The empreſs of Ruſſia and king of Pruſſia, in the mean time, continued to iſſue forth new declarations in favour of the diſſidents; and the Ruſſian troops in Poland were gradually augmented to 30,000 men. Great numbers of other confederacies were alſo formed in different parts of the kingdom. Theſe at firſt took little part in the affairs of the diſſidents: they complained only of the adminiſtration of public affairs, into which they alleged that innovations had been introduced, and were therefore for ſome time called *confederations of malcontents*. All theſe confederacies publiſhed manifeſtoes, in

in which they recommended to the inhabitants to quarter and treat the Ruſſian troops as the defenders of the Poliſh liberties.

98 General confederacy.

The different confederacies of malcontents formed in the 24 diſtricts of Lithuania united at Wilna on the 22d of June; and that general confederacy re-eſtabliſhed prince Radzivil, who had married the king's ſiſter, in his liberty, eſtates, and honour, of which he had been deprived in 1764 by the ſtates of that duchy. On the 23d of June prince Radzivil was choſen grand marſhal of the general confederacy of all Poland, which then began to be called the *national confederacy*, and was ſaid to be compoſed of 72,000 noblemen and gentlemen.

The general confederacy took ſuch meaſures as appeared moſt proper for ſtrengthening their party. They ſent to the ſeveral waywodes of the kingdom, requiring their compliance with the following articles: 1. That all the gentlemen who had not ſigned the confederacy ſhould do it immediately; 2. That all the courts of juſtice ſhould ſubſiſt as formerly, but not judge any of the confederates; 3. That the marſhals of the crown ſhould not paſs any ſentence without the participation of at leaſt four of the confederates; and, 4. That the marſhals of the crown and the treaſurers ſhould be immediately reſtored to the poſſeſſion of their reſpective rights. The Catholic party in the mean time were not idle. The biſhop of Cracow ſent a very pathetic and zealous letter to the dietines aſſembled at Warſaw on the 15th of Auguſt, in which he exhorted them to arm their nuncios with courage, by giving them orthodox and patriotic inſtructions, that they might not grant the diſſidents new advantages beyond thoſe which were ſecured to them by the conſtitutions of the country, and treaties with foreign powers, &c. The pope alſo ſent briefs to the king, the great chancellor, the nobleſſe, biſhops of the kingdom, and to the prince primate, with ſuch arguments and exhortations as were thought moſt proper to ward off the impending danger. Councils in the mean time were frequently held at the biſhop of Cracow's palace, where all the prelates at Warſaw aſſembled.

On the 26th of September 1767 the confederacy of diſſidents was united with the general confederacy of malcontents in the palace of prince Radzivil, who on that occaſion expreſſed great friendſhip for the diſſidents. In a few days after, the Ruſſian troops in the capital were reinforced, and a conſiderable body of them was poſted at about five miles diſtance.

99 Tumults in the diet.

On the 5th of October an extraordinary diet was held: but the affair of the diſſidents met with ſuch oppoſition, that it was thought neceſſary to adjourn the meeting till the 12th; during which interval, every expedient was uſed to gain over thoſe who oppoſed prince Radzivil's plan. This was, to appoint a commiſſion, furniſhed with full power to enter into conference with prince Repnin, the Ruſſian ambaſſador, concerning the affairs of the diſſidents. Notwithſtanding all the pains taken, however, the meeting of the 12th proved exceedingly tumultuous. The biſhops of Cracow and Kiow, with ſome other prelates, and ſeveral magnats, declared, that they would never conſent to the eſtabliſhment of ſuch a commiſſion; and at the ſame time ſpoke with more vehemence than ever againſt the pretenſions of the diſſidents. Some of the deputies anſwered with great warmth; which occaſioned ſuch animoſities, that the meeting was again adjourned till the 16th.

10[0] Viole[nt] proce[edings] of th[e Ruſ]ſians.

On the 13th the biſhops of Cracow and Kiow, the palatine of Cracow, and the ſtaroſte of Dolmſki, were carried off by Ruſſian detachments. The crime alleged againſt them, in a declaration publiſhed next day by prince Repnin, was, that they had been wanting in reſpect to the dignity of the empreſs of Ruſſia, by attacking the purity of her intentions towards the republic; though ſhe was reſolved to continue her protection and aſſiſtance to the general confederacy united for preſerving the liberties of Poland, and correcting all the abuſes which had been introduced into the government, &c.

It was probably owing to this violent proceeding of the Ruſſians, that prince Radzivil's plan was at laſt adopted, and ſeveral new regulations were made in favour of the diſſidents. Theſe innovations, however, ſoon produced a civil war, which at laſt ended in the ruin of the kingdom. In the beginning of the year 1768, a new confederacy was formed in Podolia, a province bordering on Turky, which was afterwards called the *confederacy of Bar*. The intention of it was, to aboliſh, by force of arms, the new conſtitutions, particularly thoſe in favour of the diſſidents. The members of the new confederacy likewiſe expreſſed great reſentment againſt the carrying away the biſhops of Cracow, &c. and ſtill detaining them in cuſtody.

10[1] Confe[dera]cy of [Bar].

Podolia was reckoned the fitteſt place for the purpoſe of the confederates, as they imagined the Ruſſians could not attack them there without giving umbrage to the Ottoman court. Similar confederacies, however, were quickly entered into throughout the kingdom: the clergy excited all ranks of men to exert themſelves in defence of their religion; and ſo much were their exhortations regarded, that even the king's troops could not be truſted to act againſt theſe confederates. The empreſs of Ruſſia threatened the new confederates as diſturbers of the public tranquillity, and declared that her troops would act againſt them if they perſiſted. It was, however, ſome time before the Ruſſian troops were conſiderably reinforced; nor did they at firſt ſeem inclined to act with the vigour which they might have exerted. A good many ſkirmiſhes ſoon happened between theſe two contending parties, in which the confederates were generally defeated. In one of theſe the latter being worſted, and hardly preſſed, a number of them paſſed the Nieſter, and took refuge in Moldavia. This province had formerly belonged to Poland, but was now ſubject to the Grand Signior: the Ruſſians, however, purſued their enemies into Moldavia; but in order to prevent any offence being taken by the Porte, prince Repnin wrote to the Ruſſian reſident at Conſtantinople, to intimate there, that the conduct of the Ruſſian colonel who commanded the party was quite contrary to the orders of his court, and that therefore he would be turned out of his poſt.

Great cruelty in the mean time was exerciſed againſt the diſſidents where there were no Ruſſian troops to protect them. Towards the end of October 1769, prince Martin Lubomirſki, one of the ſouthern confederates, who had been driven out of Poland, and had taken ſhelter with ſome of his adherents among the mountains of Hungary, got a manifeſto poſted up on ſeveral of the churches of Cracow, in which he invited the

the nation to a general revolt, and aſſuring them of the aſſiſtance of the Ottoman Porte, with whom he pretended to have concluded a treaty. This was the beginning of hoſtilities between the Turks and Ruſſians, which were not terminated but by a vaſt effuſion of blood on both ſides.

The unhappy kingdom of Poland was the firſt ſcene of this war, and in a ſhort time was reduced to the moſt deplorable ſituation. In the end of the year 1768, the peaſants of the Greek religion in the Poliſh Ukraine, and province of Kiow, took up arms, and committed the greateſt ravages, having, as they pretended, been threatened with death by the confederates unleſs they would turn Roman Catholics. Againſt theſe inſurgents the Ruſſians employed their arms, and made great numbers of them priſoners. The reſt took refuge among the Haidamacks; by whom they were ſoon joined, and in the beginning of 1769 entered the Ukraine in conjunction with them, committing everywhere the moſt horrid maſſacres. Here, however, they were at laſt defeated by the Poliſh troops, at the ſame time that ſeveral of the confederacies in Poland were ſeverely chaſtiſed. Soon after, the Chan of the Crim Tartars, having been repulſed with loſs in an attempt on New Servia, entered the Poliſh territories, where he left frightful marks of his inhumanity upon ſome innocent and defenceleſs perſons. This latter piece of conduct, with the cruelties exerciſed by the confederates, induced the Poliſh coſſacks of Braclau and Kiovia, amounting to near 30,000 effective men, to join the Ruſſians, in order to defend their country againſt theſe deſtroyers. Matters continued much in the ſame way during the reſt of the year 1769; and in 1770, ſkirmiſhes frequently happened between the Ruſſians and confederates, in which the latter were almoſt always worſted; but they took care to revenge themſelves by the moſt barbarous cruelties on the diſſidents, wherever they could find them. In 1770, a conſiderable number of the confederates of Bar, who had joined the Turks, and been exceſſively ill uſed by them, came to an accommodation with the Ruſſians, who took them under their protection on very moderate terms.—Agriculture in the mean time had been ſo much neglected, that the crop of 1770 was very deficient. This encouraged a number of deſperadoes to aſſociate under the denomination of *confederates*, who were guilty of ſtill greater exceſſes than thoſe who had been under ſome kind of regulation. Thus a great part of the country was at laſt reduced to a mere deſert, the inhabitants being either exterminated, or carried off to ſtock the remote Ruſſian plantations, from whence they never could return.

In the year 1771, the confederacies, which ſeemed to have been extinguiſhed, ſprung up afreſh, and increaſed to a prodigious degree. This was occaſioned by their having been ſecretly encouraged and ſupplied with money by France. A great number of French officers engaged as volunteers in their ſervice; who, having introduced diſcipline among their troops, they acted with much greater vigour than formerly, and ſometimes proved too hard for their enemies. Theſe gleams of ſucceſs proved at laſt their total ruin. The Ruſſians were reinforced, and properly ſupported. The Auſtrian and Pruſſian troops entered the country, and advanced on different other ſides; and the confederates found themſelves in a ſhort time entirely ſurrounded by their enemies, who ſeemed to have nothing leſs in view than an abſolute conqueſt of the country, and ſharing it among themſelves. Poland.

104 Attempt to aſſaſſinate the king.

Before matters came to this criſis, however, the confederates formed a deſign of aſſaſſinating the king, on account of his ſuppoſed attachment to the diſſidents. Of this ſingular occurrence we have the following account in the travels of Mr Coxe, communicated to the author by Mr Wraxall.—"A Poliſh nobleman, named *Pulaſki*, a general in the army of the confederates, was the perſon who planned the atrocious enterpriſe; and the conſpirators who carried it into execution were about 40 in number, and were headed by three chiefs, named *Lukawſki*, *Strawenſki*, and *Koſinſki*. Theſe three chiefs had been engaged and hired to that purpoſe by Pulaſki, who in the town of Czetſchokow in Great Poland obliged them to ſwear in the moſt ſolemn manner, by placing their hands between his, either to deliver the king alive into his hands, or, in caſe that was impoſſible, to put him to death. The three chiefs choſe 37 perſons to accompany them. On the ſecond of November, about a month after they had quitted Czetſchokow, they obtained admiſſion into Warſaw, unſuſpected or undiſcovered, by the following ſtratagem. They diſguiſed themſelves as peaſants who came to ſell hay, and artfully concealed their ſaddles, arms, and clothes, under the loads of hay which they brought in waggons, the more effectually to eſcape detection.

"On Sunday night, the third of September 1771, a few of theſe conſpirators remained in the ſkirts of the town; and the others repaired to the place of rendezvous, the ſtreet of the Capuchins, where his majeſty was expected to paſs by about his uſual hour of returning to the palace. The king had been to viſit his uncle prince Czartoriſki, grand chancellor of Lithuania, and was on his return from thence to the palace between nine and ten o'clock. He was in a coach, accompanied by at leaſt 15 or 16 attendants, beſide an aid-de-camp in the carriage: ſcarce was he at the diſtance of 200 paces from prince Czartoriſki's palace, when he was attacked by the conſpirators, who commanded the coachman to ſtop on pain of inſtant death. 105 Who is taken priſoner,

They fired ſeveral ſhot into the carriage, one of which paſſed through the body of a heyduc, who endeavoured to defend his maſter from the violence of the aſſaſſins. Almoſt all the other perſons who preceded and accompanied his majeſty were diſperſed; the aid-de-camp abandoned him, and attempted to conceal himſelf by flight. Meanwhile the king had opened the door of his carriage with the deſign of effecting his eſcape under ſhelter of the night, which was extremely dark. He had even alighted, when the aſſaſſins ſeized him by the hair, exclaiming in Poliſh, with horrible execrations, 'We have thee now; thy hour is come.' One of them diſcharged a piſtol at him ſo very near, that he felt the heat of the flaſh; while another cut him acroſs the head with his ſabre, which penetrated to the bone. 106 And wounded.

They then laid hold of his majeſty by the collar, and, mounting on horſeback, dragged him along the ground between their horſes at full gallop for near 500 paces through the ſtreets of Warſaw.

"Soon finding, however, that he was incapable of following them on foot, and that he had already almoſt

Poland. loft his refpiration from the violence with which they had dragged him, they fet him on horfeback; and then redoubled their fpeed for fear of being overtaken. When they came to the ditch which furrounds Warfaw, they obliged him to leap his horfe over. In the attempt the horfe fell twice, and at the fecond fall broke its leg. They then mounted his majefty upon another, all covered as he was with dirt.

107 And rifled. "The confpirators had no fooner croffed the ditch, than they began to rifle the king, tearing off the order of the Black Eagle of Pruffia which he wore round his neck, and the diamond crofs hanging to it. He requefted them to leave his handkerchief, which they confented to: his tablets efcaped their rapacity. A great number of the affaffins retired after having thus plundered him, probably with intent to notify to their refpective leaders the fuccefs of their enterprife; and the king's arrival as a prifoner. Only feven remained with him, of whom Kofinfki was the chief. The night was exceedingly dark; they were abfolutely ignorant of the way; and, as the horfes could not keep their legs, they obliged his majefty to follow them on foot, with only one fhoe, the other being loft in the dirt.

"They continued to wander through the open meadows, without following any certain path, and without getting to any diftance from Warfaw. They again mounted the king on horfeback, two of them holding

108 His prefence of mind remarkable him on each fide by the hand, and a third leading his horfe by the bridle. In this manner they were proceeding, when his majefty, finding they had taken the road which led to a village called *Burakow*, warned them not to enter it, becaufe there were fome Ruffians ftationed in that place who might probably attempt to refcue him (A). Finding himfelf, however, incapable of accompanying the affaffins in the painful pofture in which they held him kept down on the faddle, he requefted them, fince they were determined to oblige him to proceed, at leaft to give him another horfe and a boot. This requeft they complied with; and continuing their progrefs through almoft impaffable lands, without any road, and ignorant of their way, they at length found themfelves in the wood of Bielany, only a league diftant from Warfaw. From the time they had paffed the ditch they repeatedly demanded of Kofinfki their chief, if it was not yet time to put the king to death; and thefe demands were reiterated in proportion to the obftacles and difficulties they encountered, till they were fuddenly alarmed by a Ruffian patrole or detachment. Inftantly holding council, four of them difappeared, leaving him with the other three, who compelled him to walk on. Scarce a quarter of an hour after, a fecond Ruffian guard challenged them anew. Two of the affaffins then fled, and the king remained alone with Kofinfki the chief, both on foot. His majefty, exhaufted with all the fatigue which he had undergone, implored his conductor to ftop, and fuffer him to take a moment's repofe. Kofinfki refufed it, menacing him with his naked fabre; and at the fame time informed him, that beyond the wood they fhould find a carriage. They continued their walk, till they came to the door of the convent of Bielany. Kofinfki appeared loft in thought, and fo much agitated by his reflections, that the king perceiving his diforder, and obferving that he wandered without knowing the road, faid to him, 'I fee you are at lofs which way to proceed. Let me enter the convent of Bielany, and do you provide for your own fafety.' 'No (replied Kofinfki), I have fworn.'

"They proceeded till they came to Mariemont, a fmall palace belonging to the houfe of Saxony, not above half a league from Warfaw: here Kofinfki betrayed fome fatisfaction at finding where he was, and the king ftill demanding an inftant's repofe, he confented at length. They fat down together on the ground, and the king employed thefe moments in endeavouring to foften his conductor, and induce him to favour or permit his efcape. His majefty reprefented the atrocity of the crime he had committed in attempting to murder his fovereign, and the invalidity of an oath taken to perpetrate fo heinous an action: Kofinfki lent attention to this difcourfe, and began to betray fome marks of remorfe. But (faid he), if I fhould confent and reconduct you to Warfaw, what will be the confequence? I fhall be taken and executed! I give you my word (anfwered his majefty), that you fhall fuffer no harm; but if you doubt my promife, efcape while there is yet time. I can find my way to fome place of fecurity; and I will certainly direct your purfuers to take the contrary road to that which you have chofen.' Kofinfki could not any longer contain himfelf, but, throwing himfelf at the king's feet, implored forgivenefs for the crime he had committed; and fwore to protect him againft every enemy, relying totally on his generofity for pardon and prefervation. His majefty reiterated to him his affurances of fafety. Judging, however, that it was prudent to gain fome afylum without delay, and recollecting that there was a mill at fome confiderable diftance, he immediately made towards it. Kofinfki knocked, but in vain; no anfwer was given: he then broke a pane of glafs in the window, and intreated for fhelter to a nobleman who had been plundered by robbers. The miller refufed, fuppofing them to be banditti, and continued for more than half an hour to perfift in his denial. At length the king approached, and fpeaking through the broken pane, endeavoured to perfuade him to admit them under his roof, adding, 'If we were robbers, as you fuppofe, it would be very eafy for us to break the whole window, inftead of one pane of glafs.' This argument prevailed. They at length opened the door, and admitted his majefty. He immediately wrote a note to General Coccei, colonel of the foot-guards, informing him of his danger and miraculous efcape.

"When the meffenger arrived with the note, the aftonifhment and joy was incredible. Coccei inftantly rode to the mill, followed by a detachment of the guards. He

(A) "This intimation, which the king gave to his affaffins, may at firft fight appear extraordinary and unaccountable, but was really dictated by the greateft addrefs and judgment. He apprehended with reafon, that, on the fight of a Ruffian guard, they would inftantly put him to death with their fabres, and fly; whereas by informing them of the danger they incurred, he in fome meafure gained their confidence: in effect, this behaviour of the king feemed to foften them a little, and made them believe he did not mean to efcape from them."

He met Kofinfki at the door with his fabre drawn, who admitted him as foon as he knew him. The king had funk into a fleep, caufed by his fatigue; and was ftretched on the ground, covered with the miller's cloak. Coccei immediately threw himfelf at his majefty's feet, calling him his fovereign, and kiffing his hand. It is not eafy to paint or defcribe the aftonifhment of the miller and his family, who inftantly imitated Coccei's example, by throwing themfelves on their knees (B). The king returned to Warfaw in General Coccei's carriage, and reached the palace about five in the morning. His wound was found not to be dangerous; and he foon recovered the bruifes and injuries which he had fuffered during this memorable night. So extraordinary an efcape is fcarce to be paralleled in hiftory, and affords ample matter of wonder and furprife.

"It is natural to inquire what is become of Kofinfki, the man who faved his majefty's life, and the other confpirators. He was born in the palatinate of Cracow, and of mean extraction; having affumed the name of *Kofinfki* (c), which is that of a noble family, to give himfelf credit. He had been created an officer in the troops of the confederates under Pulafki. It would feem as if Kofinfki began to entertain the idea of preferving the king's life from the time when Lukawfki and Strawenfki abandoned him; yet he had great ftruggles with himfelf before he could refolve on this conduct, after the folemn engagements into which he had entered. Even after he had conducted the king back to Warfaw, he expreffed more than once his doubts of the propriety of what he had done, and fome remorfe for having deceived his employers. He was detained under a very ftrict confinement, and obliged to give evidence againft his two companions Lukawfki and Strawenfki, who were beheaded, his majefty having obtained for them from the diet a mitigation of the horrible punifhment which the laws of Poland inflict upon regicides. About a week after the execution of thefe confpirators, Kofinfki was fent out of Poland, after the king had fettled upon him an annual penfion which he enjoyed at Semigallia in the papal territories."

110 Upon the king's return to Warfaw he was received with the utmoft demonftrations of joy. Every one exclaimed with rapture, "The king is alive!" and all ftruggled to get near him, to kifs his hand, or even to touch his clothes. But neither the virtues nor the popularity of the fovereign could allay the factious fpirit of the Poles, nor prevent the difmemberment of his kingdom.

111 "The partition of Poland was firft projected by the king of Pruffia. Polifh or Weftern Pruffia had long been an object of his ambition: exclufive of its fertility, commerce, and population, its local fituation rendered it highly valuable to that monarch; it lay between his German dominions and Eaftern Pruffia, and while poffeffed by the Poles, cut off at their will all communication between them." The period was now arrived when the fituation of Poland feemed to promife the eafy acquifition of this valuable province. "Frederic purfued it, however, with all the caution of an able politician. On the commencement of the troubles, he fhowed no eagernefs to interfere in the affairs of this country; and although he had concurred with the emprefs of Ruffia in raifing Staniflaus Auguftus to the throne of Poland, yet he declined taking any active part in his favour againft the confederates. Afterwards, when the whole kingdom became convulfed throughout with civil commotions (1769), and defolated likewife by the plague, he, under pretence of forming lines to prevent the fpreading of the infection, advanced his troops into Polifh Pruffia, and occupied that whole diftrict.

"Though now completely mafter of the country, and by no means apprehenfive of any formidable refiftance from the difunited and diftracted Poles, yet, as he was well aware that the fecurity of his new acquifition depended upon the acquiefcence of Ruffia and Auftria, he planned the partition of Poland. He communicated the project to the emperor, either upon their interview at Niefs in Silefia in 1769, or in that of the following year at Neuftadt in Auftria; from whom the overture met with a ready concurrence. To induce the emprefs of Ruffia to acquiefce in the fame project, he difpatched his brother Henry to Peterfburg, who fuggefted to the emprefs that the houfe of Auftria was forming an alliance with the Porte, with which fhe was then at war; that if fuch alliance took place, it would create a moft formidable combination againft her; that, neverthelefs, the friendfhip of that houfe was to be purchafed by acceding to the partition; that upon this condition the emperor was willing to renounce his connection with the Grand Signior, and would fuffer the Ruffians to profecute the war without interruption. Catharine, anxious to pufh her conquefts againft the Turks, and dreading the interpofition of the emperor in that quarter; perceiving likewife, from the intimate union between the courts of Vienna and Berlin, that it would not be in her power, at the prefent juncture, to prevent the intended partition – clofed with the propofal, and felected no inconfiderable portion of the Polifh territories for herfelf. The treaty was figned at Peterfburg in the beginning of February 1772, by the Ruffian, Auftrian, and Pruffian plenipotentiaries. It would be tedious to enter into a detail of the pleas urged by the three powers in favour of their feveral demands; it would be no lefs uninterefting to lay before the reader the anfwers and remonftrances of the king and fenate, as well as the appeals to the other ftates which had guaranteed the poffeffions of Poland. The courts of London, Paris, Stockholm, and Copenhagen, remonftrated againft the ufurpations; but remonftrances without affiftance could be of no effect. Poland fubmitted to the difmemberment not without the moft violent ftruggles, and now for the firft time felt and lamented the fatal effects of faction and difcord.

A diet being demanded by the partitioning powers, in order to ratify the ceffion of the provinces, it met on the 19th of April 1773; and fuch was the fpirit of the members, that, notwithftanding the deplorable fituation of

(B) "I have been (fays Mr Wraxall) at this mill, rendered memorable by fo fingular an event. It is a wretched Polifh hovel, at a diftance from any houfe. The king has rewarded the miller to the extent of his wifhes in building him a mill upon the Viftula, and allowing him a fmall penfion."

(c) His real name was John Kutfma.

of their country, the threats and bribes of the three powers, the partition-treaty was not carried through without much difficulty. For some time the majority of the nuncios appeared determined to oppose the dismemberment, and the king firmly persisted in the same resolution. The ambassadors of the three courts enforced their requisitions by the most alarming menaces, and threatened the king with deposition and imprisonment. They also gave out by their emissaries, that in case the diet continued refractory, Warsaw should be pillaged. This report was industriously circulated, and made a sensible impression upon the inhabitants. By menaces of this sort, by corrupting the marshal of the diet, who was accompanied with a Russian guard; in a word, by bribes, promises, and threats, the members of the diet were at length prevailed on to ratify the dismemberment.

114 Provinces seized by the three partitioning powers.

Of the dismembered countries, the Russian province is the largest, the Austrian the most populous, and the Prussian the most commercial. The population of the whole amounts to near 5,000,000 souls; the first containing 1,500,000, the second 2,500,000, and the third 860,000. Western Prussia was the greatest loss to Poland, as by the dismemberment of that province the navigation of the Vistula entirely depends upon the king of Prussia: by the loss consequently of this district a fatal blow was given to the trade of Poland; for his Prussian majesty has laid such heavy duties upon the merchandize passing to Dantzic, as greatly to diminish the commerce of that town, and to transfer a considerable portion of it to Memel and Konigsburgh.

The partitioning powers, however, did less injury to the republic by dismembering its fairest provinces, than by perpetuating the principles of anarchy and confusion, and establishing on a permanent footing that exorbitant liberty which is the parent of faction, and has proved the decline of the republic. Under pretence of amending the constitution, they have confirmed all its defects, and have taken effectual precautions to render this unhappy country incapable of emerging from its present deplorable state, as has been lately seen in the failure of the most patriotic attempt that was perhaps ever made by a king to reform the constitution of his kingdom.

115 The kings of Poland originally hereditary,

The kings of Poland were anciently hereditary and absolute; but afterwards became elective and limited, as we find them at this day. In the reign of Louis, towards the end of the 14th century, several limitations were laid on the royal prerogative. In that of Casimir IV. who ascended the throne in 1446, representatives from the several palatinates were first called to the diet; the legislative power till then having been lodged in the states, and the executive in the king and senate.

116 Afterwards elective.

On the decease of Sigismund Augustus, it was enacted by law, "That the choice of a king for the future should perpetually remain free and open to all the nobles of the kingdom;" which law has accordingly been hitherto observed.

Universal History.

"As soon as the throne is vacant, all the courts of justice, and other ordinary springs of the machine of government, remain in a state of inaction, and all the authority is transferred to the primate, who, in quality of interrex, has in some respects more power than the king himself; and yet the republic takes no umbrage at it, because he has not time to make himself formidable. He notifies the vacancy of the throne to foreign princes, which is in effect proclaiming that a crown is to be disposed of; he issues the *universalia*, or circular letters for the election; gives orders to the starosts (a sort of military officers who have great authority, and whose proper business it is to levy the revenue) to keep a strict guard upon the fortified places, and to the grand-generals to do the same upon the frontiers, towards which the army marches.

117 Place and manner of the election.

"The place of election is the field of Wola, at the gates of Warsaw. All the nobles of the kingdom have a right of voting. The poles encamp on the left side of the Vistula, and the Lithuanians on the right, each under the banners of their respective palatinates, which makes a sort of civil army; consisting of between a hundred and fifty and two hundred thousand men, assembled to exercise the highest act of freedom. Those who are not able to provide a horse and a sabre stand behind on foot, armed with scythes, and do not seem at all less proud than the rest, as they have the same right of voting.

"The field of election is surrounded by a ditch with three gates, in order to avoid confusion, one to the east for Great Poland, another to the south for Little Poland, and a third to the west for Lithuania. In the middle of the field, which is called *Kolau*, is erected a great building of wood, named the szopa or hall for the senate, at whose debates the deputies are present, and carry the result of them to the several palatinates. The part which the marshal acts upon this occasion is very important; for, being the mouth of the nobility, he has it in his power to do great service to the candidates; he is also to draw up the instrument of election, and the king elect must take it only from his hand.

"It is prohibited, upon pain of being declared a public enemy, to appear at the election with regular troops, in order to avoid all violence. But the nobles, who are always armed with pistols and sabres, commit violence against one another, at the time that they cry out 'liberty!'

"All who aspire openly to the crown are expressly excluded from the field of election, that their presence may not constrain the voters. The king must be elected *nemine contradicente*, by all the suffrages without exception. The law is founded upon this principle, that when a great family adopts a father, all the children have a right to be pleased. The idea is plausible in speculation; but if it was rigorously kept to, Poland could have no such thing as a lawful king. They therefore give up a real unanimity, and content themselves with the appearance of it; or rather, if the law, which prescribes it, cannot be fulfilled by means of money, they call in the assistance of the sabre.

"Before they come to this extremity, no election can possibly be carried on with more order, decency, and appearance of freedom. The primate in few words recapitulates to the nobles on horseback the respective merit of the candidates; he exhorts them to choose the most worthy, invokes heaven, gives his blessing to the assembly, and remains alone with the marshal of the diet, while the senators disperse themselves into the several palatinates, to promote an unanimity of sentiments. If they succeed, the primate goes himself to collect the votes, naming once more all the candidates. 'Szoda (answer the nobles), that is the man we choose;' and

Poland. and inftantly the air refounds with his name, with cries of *vivat*, and the noife of piftols. If all the palatines agree in their nominations, the primate gets on horfeback; and then the profoundeft filence fucceeding to the greateft noife, he afks three times if all are fatisfied? and after a general approbation, three times proclaims the king; and the grand-marfhal of the crown repeats the proclamation three times at the three gates of the camp. How glorious a king this, if endued with royal qualities! and how inconteftable his title in the fuffrages of a whole people! But this fketch of a free and peaceable election is by no means a reprefentation of what ufually happens. The corruption of the great, the fury of the people, intrigues and factions, the gold and the arms of foreign powers, frequently fill the fcene with violence and blood."

118 *pacta conventa.* Before the king is proclaimed, the *pacta conventa* is read aloud to him, which on his knees at the altar he fwears to obferve. As this contract, which is drawn up, methodized, and approved, by the fenate and nobility, may be deemed the great charter of Poland, we fhall enumerate the principal articles of which it confifts. Thefe are, that the king fhall not attempt to encroach on the liberty of the people, by rendering the crown hereditary in his family; but that he fhall preferve all the cuftoms, laws, and ordonnances, refpecting the freedom of election: that he fhall ratify all treaties fubfifting with foreign powers which are approved by the diet: that it fhall be his chief ftudy to cultivate peace, preferve the public tranquillity, and promote the intereft of the realm: that he fhall not coin money except in the name of the republic, nor appropriate to himfelf the advantages arifing from coinage: that in declaring war, concluding peace, making levies, hiring auxiliaries, or admitting foreign troops upon any pretext within the Polifh dominions, the confent of the diet and fenate fhall be neceffary: that all offices and preferments fhall be given to the natives of Poland and Lithuania; and that no pretence fhall excufe or palliate the crime of introducing foreigners into the king's council or the departments of the republic: that the officers of his majefty's guards fhall be Poles or Lithuanians; and that the colonel fhall abfolutely be a native of Poland, and of the order of nobility: that all the officers fhall be fubordinate to the authority of the marefchal: that no individual fhall be vefted with more employments than the law allows: that the king fhall not marry without the approbation of the fenate; and that the houfehold of the queen fhall be determined and regulated by the republic: that the fovereign fhall never apply his private fignet to acts and papers of a public nature: that the king fhall difpofe of the offices both of the court and of the republic; and regulate with the fenate the number of forces neceffary for the defence of the kingdom: that he fhall adminifter juftice by the advice of the fenate and his council: that the expences of his civil lift fhall be the fame with thofe of his predeceffors: that he fhall fill up all vacancies in the fpace of fix weeks: that this fhall be his firft bufinefs in the diet, obliging the chancellor to publifh his appointments in due form: that the king fhall not diminifh the treafure kept at Cracow; but, on the contrary, endeavour to augment that and the number of the crown-jewels: that he fhall borrow no money without the confent of the diet: that he fhall not equip a naval force without the confent and full approbation of the republic: that he fhall profefs the Roman Catholic faith, promote, maintain, and defend it, through all the Polifh dominions; and finally, that all their feveral liberties, rights, and privileges, fhall be preferved to the Polanders and Lithuanians in general, and to all the diftricts and provinces contained within each of thefe great divifions, without change, alteration, or the fmalleft violation, except by the confent of the republic. To thefe articles a variety of others are added, according to circumftances and the humour of the diet; but what we have recited form the ftanding conditions, which are fcarce ever altered or omitted.

119 The diet of Poland, and The diet of Poland is compofed of the king, the fenate, bifhops, and the deputies of the nobility or gentry of every palatinate, called, in the collective capacity, *comitia togata*; that is, when the ftates affemble in the city without arms and horfes; or *comitia paludata*, when they meet in the fields armed, as during an interregnum, at the diet of election. It is a prerogative of the crown to affemble the diet at any particular place, except on occafion of a coronation, which the cuftom of the country requires fhould be celebrated at the capital. For a number of years, indeed, the diet regularly affembled at Warfaw; but, on complaint made by the Lithuanians, it was agreed, that every third diet fhould be held at Grodno. "When it is propofed to hold a general diet, the king, or, in cafe of an interregnum, the primate, iffues writs to the palatines of the feveral provinces, fpecifying the time and place of the meeting. A fketch likewife is fent of the bufinefs to be deliberated on by the affembly; the fenate is confulted in this particular, and fix weeks are allowed the members to prepare themfelves for the intended feffion. It is remarkable, that the diet never fits more than fix weeks in the moft critical conjunctures and preffing emergencies: they have been known to break up in the middle of an important debate, and to leave the bufinefs to a future meeting. This cuftom hath been juftly efteemed one of the greateft defects of the Polifh conftitution, which probably owes its origin to convenience, but is now fuperftitioufly obferved from whim and caprice. On receipt of the king's writ, the palatine communicates the meeting of the diet to all the caftellans, ftaroftas, and other inferior officers and gentry within his jurifdiction, requiring them to affemble on a certain day to elect deputies, and take into confideration the

120 Dietines. bufinefs fpecified in the royal fummons. Thefe meetings are called *petty diets*, *dietines*, or *lantage*, in the language of the country; every gentleman poffeffing three acres of land having a vote, and matters being determined by a majority; whereas in the general diet decrees are only valid when the whole body is unanimous. Every palatinate has three reprefentatives, though the bufinefs devolves on one called a *nuncio*, who is elected for his ability and experience; and the other two are added only to give weight to this leading member, and do honour by their magnificent appearance to the palatinate they reprefent. As thefe deputies, fince the reign of Cafimir III. have feats in the diet, it naturally divides the general affembly into two bodies, the upper and lower; the one being compofed of the fenate, the fuperior clergy, and the great officers; the other of the reprefentatives of the palatinates, who prepare all bufinefs for the fuperior body.

"The

Poland.

"The firſt buſineſs of the aſſembly is to chooſe a mareſchal; upon which occaſion the debates and tumults run ſo high, that the whole time for the ſeſſion of the diet is often conſumed in altercation and wrangling about the election of a ſpeaker, who has now nothing farther to do than return quietly to his own home. After his election, he kiſſes the king's hand; and the chancellor, as the royal repreſentative, reports the matters to be deliberated by the diet. Then the mareſchal acquaints the king with the inſtructions of the deputies from their conſtituents, the grievances which they would have redreſſed, and the abuſes they require to be remedied. He likewiſe requeſts of his majeſty to fill up the vacant offices and benefices, according to law; and he is anſwered by a ſet ſpeech from the chancellor, who reports the king's inclination to ſatisfy his people, as ſoon as he hath conſulted his faithful ſenate There is ſomething very peculiarly abſurd in ſome of the cuſtoms obſerved by the Poliſh diet: one in particular merits attention. Not only an unanimity of voices is neceſſary to paſs any bill, and conſtitute a decree of the diet, but every bill muſt likewiſe be aſſented to unanimouſly, or none can take effect. Thus, if out of twenty bills one ſhould happen to be oppoſed by a ſingle voice, called *liberum veto*, all the reſt are thrown out, and the diet meets, deliberates, and debates, for ſix weeks to no purpoſe.

121 Abſurd cuſtoms obſerved in the diet.

122 The *liberum veto*.

"To add to the other inconveniences attending the conſtitution of the diet of Poland, a ſpirit of venality in the deputies, and a general corruption, hath ſeized all ranks and degrees in that aſſembly. Here, as in ſome other countries, the cry of liberty is kept up for the ſake of private intereſt. Deputies come with a full reſolution of profiting by their patriotiſm, and not lowering their voice without a gratification. Determined to oppoſe the moſt ſalutary meaſures of the court, they either withdraw from the aſſembly, proteſt againſt all that ſhall be tranſacted in their abſence, or elſe excite ſuch a clamour as renders it neceſſary for the court to ſilence them by ſome lucrative penſion, donation, or employment. Thus not only the buſineſs of the aſſembly is obſtructed by its own members, but frequently by largeſſes from neighbouring powers, and ſometimes by the liberality of an open enemy, who has the art of diſtributing his money with diſcretion.

123 The ſenate of Poland.

"Perhaps the moſt reſpectable department of the Poliſh government is the ſenate, compoſed of the biſhops, palatines, caſtellans, and ten officers of ſtate, who derive a right from their dignities of ſitting in that aſſembly; in all amounting to 144 members, who are ſtyled *ſenators of the kingdom* or *counſellors of the ſtate*, and have the title of *excellency*, a dignity ſupported by no penſion or emoluments neceſſarily annexed. The ſenate preſides over the laws, is the guardian of liberty, the judge of right, and the protector of juſtice and equity. All the members, except the biſhops, who are ſenators *ex officio*, are nominated by the king, and they take an oath to the republic before they are permitted to enter upon their functions. Their honours continue for life: at the general diet they ſit on the right and left of the ſovereign, according to their dignity, without regard to ſeniority. They are the mediators between the monarch and the ſubject, and, in conjunction with the king, ratify all the laws paſſed by the nobility. As a ſenator is bound by oath to maintain the liberties of the republic, it is thought no diſreſpect to majeſty that they remind the prince of his duty. They are his counſellors, and this freedom of ſpeech is an inſeparable prerogative of their office."

Such was the conſtitution of Poland before it was new-modelled by the partitioning powers. That it was a very bad conſtitution needs no proof; but thoſe foreign reformers did not improve it. For two centuries at leaſt, the Poles have with great propriety denominated their government a republic, becauſe the king is ſo exceedingly limited in his prerogative, that he reſembles more the chief of a commonwealth than the ſovereign of a powerful monarchy. That prerogative, already too confined to afford protection to the peaſants, groaning under the ariſtocratic tyranny of the nobles, was, after the partition treaty, ſtill further reſtrained by the eſtabliſhment of the *permanent council*, which was veſted with the whole executive authority, leaving to the ſovereign nothing but the name. The permanent council conſiſts of 36 perſons, elected by the diet out of the different orders of nobility; and though the king, when preſent, preſides in it, he cannot exert a ſingle act of power but with the conſent of the majority of perſons, who may well be called his *colleagues*. 124

124 The permanent council.

That the virtuous and accompliſhed Staniſlaus ſhould labour to extricate himſelf and the great body of the people from ſuch unparalleled oppreſſion, and that the more reſpectable part of the nation ſhould wiſh to give to themſelves and their poſterity a better form of government, was ſurely very natural and very meritorious. The influence of the partitioning powers was indeed exerted to make the king contented with his ſituation. His revenues, which before did not exceed L. 100,000, were now increaſed to three times that ſum. The republic likewiſe agreed to pay his debts, amounting to upwards of L. 400,000. It beſtowed on him alſo, in hereditary poſſeſſion, four ſtaroſties, or governments of caſtles, with the diſtricts belonging to them; and reimburſed him of the money he had laid out for the ſtate. It was alſo agreed, that the revenues of the republic ſhould be enhanced to 33 millions of florins (near two millions Sterling), and the army ſhould conſiſt of 30,000 men. Soon after the concluſion of the peace with Turky, the empreſs of Ruſſia alſo made the king a preſent of 250,000 rubles, as a compenſation for that part of his dominions which fell into her hands.

Theſe bribes, however, were not ſufficient to blind the eyes of Staniſlaus, or to cool the ardour of his patriotiſm. He laboured for poſterity, and with ſuch apparent ſucceſs, that on the 3d of May 1791, a new conſtitution of the government of Poland was eſtabliſhed by the king, together with the confederate ſtates aſſembled in double number to repreſent the Poliſh nation. That this was a perfect conſtitution, we are far from thinking; but it was probably as perfect as the inveterate prejudices of the nobles would admit of. It deviated as little as poſſible from the old forms, and was drawn up in 11 articles, reſpecting the government of the republic; to which were added 21 ſections, regulating the dietines or primary aſſemblies of Poland.

12[5] A new conſtitution eſtabliſhed in 179[1]

Of this conſtitution, the firſt article eſtabliſhed the Roman Catholic faith, with all its privileges and immunities, as the dominant national religion; granting to all other people, of whatever perſuaſion, peace in matters of faith, and the protection of government. The ſecond

12[6] Subſt[ance] of the five a[rticles] of it.

ſecond article guaranteed to the nobility or the equeſtrian order, all the privileges which it enjoyed under the kings of the houſe of Jagellan. The third and fourth articles granted to the free royal towns internal juriſdictions of their own; and exempted the peaſants from ſlavery, declaring every man free as ſoon as he ſets his foot on the territory of the republic. The fifth article, after declaring, that in civil ſociety all power ſhould be derived from the will of the people, enacted that the government of the Poliſh nation ſhould be compoſed of three diſtinct powers, the *legiſlative*, in the ſtates aſſembled; the *executive*, in the king and the council of inſpection; and the *judicial* power, in the juriſdictions exiſting, or to be eſtabliſhed. The ſixth and ſeventh articles, as being of more importance, we ſhall give in the words of the conſtitution itſelf.

VI. *The Diet*, or *the legiſlative power*, ſhall be divided into two houſes, viz. the houſe of nuncios, or deputies, and the houſe of ſenate, where the king is to preſide. The former being the repreſentative and central point of ſupreme national authority, ſhall poſſeſs the pre-eminence in the legiſlature; therefore all bills are to be decided firſt in this houſe.

1. *All General Laws*, viz. conſtitutional, civil, criminal, and perpetual taxes; concerning which matters, the king is to iſſue his propoſitions by the circular letters ſent before the dietines to every palatinate and to every diſtrict for deliberation, which coming before the houſe with the opinion expreſſed in the inſtructions given to their repreſentatives, ſhall be taken the firſt for deciſion.

2. *Particular Laws*, viz. temporal taxes; regulations of the mint; contracting public debts; creating nobles, and other caſual recompenſes; reparation of public expences, both ordinary and extraordinary; concerning war; peace; ratification of treaties, both political and commercial; all diplomatic acts and conventions relative to the laws of nations; examining and acquitting different executive departments, and ſimilar ſubjects ariſing from the accidental exigencies and circumſtances of the ſtate; in which the propoſitions, coming directly from the throne into the houſe of nuncios, are to have preference in diſcuſſion before the private bills.

In regard to the houſe of ſenate, it is to conſiſt of biſhops, palatines, caſtellans, and miniſters, under the preſidency of the king, who ſhall have but one vote, and the caſting voice in caſe of parity, which he may give either perſonally, or by a meſſage to the houſe. Its power and duty ſhall be,

1. Every general law that paſſes formally through the houſe of nuncios, is to be ſent immediately to this, which is either accepted, or ſuſpended till farther national deliberation, by a majority of votes, as preſcribed by law. If accepted, it becomes a law in all its force; if ſuſpended, it ſhall be reſumed at the next diet; and if it is then agreed to again by the houſe of nuncios, the ſenate muſt ſubmit to it.

3. Every particular law or ſtatute of the diet in matters above ſpecified, as ſoon as it has been determined by the houſe of nuncios, and ſent up to the ſenate, the votes of both houſes ſhall be jointly computed, and the majority, as deſcribed by law, ſhall be conſidered as a decree and the will of the nation. Thoſe ſenators and miniſters who, from their ſhare in executive power, are accountable to the republic, cannot have an active voice in the diet, but may be preſent, in order to give neceſſary explanations to the ſtates. Poland.

Theſe ordinary legiſlative diets ſhall have their uninterrupted exiſtence, and be always ready to meet; renewable every two years. The length of ſeſſions ſhall be determined by the law concerning diets. If convened out of ordinary ſeſſion upon ſome urgent occaſion, they ſhall only deliberate on the ſubject which occaſioned ſuch a call, or on circumſtances which may ariſe out of it.

No law or ſtatute enacted by ſuch ordinary diet can be altered or annulled by the ſame. The complement of the diet ſhall be compoſed of the number of perſons in both houſes to be determined hereafter.

The law concerning the dietines or primary elections, as eſtabliſhed by the preſent diet, ſhall be regarded as a moſt eſſential foundation of civil liberty. 129

The majority of votes ſhall decide every thing, and everywhere; therefore we aboliſh, and utterly annihilate, *liberum veto*, all ſorts of confederacies and confederate diets, as contrary to the ſpirit of the preſent conſtitution, as undermining the government, and as being ruinous to ſociety. The *liberum veto* aboliſhed.

Willing to prevent, on one hand, violent and frequent changes in the national conſtitution, yet, conſidering on the other, the neceſſity of perfecting it, after experiencing its effects on public proſperity, we determine the period of every 25 years for an extraordinary conſtitutional diet, to be held purpoſely for the reviſion and ſuch alterations of the conſtitution as may be found requiſite: which diet ſhall be circumſcribed by a ſeparate law hereafter. 130 Extraordinary diet for reviſing the conſtitution.

VII. The moſt perfect government cannot exiſt or laſt without an effectual executive power. The happineſs of the nation depends on juſt laws, but the good effects of laws flow only from their execution. Experience has taught us, that the neglecting this eſſential part of government has overwhelmed Poland with diſaſters.

Having, therefore, ſecured to the free Poliſh nation the right of enacting laws for themſelves, the ſupreme inſpection over the executive power, and the choice of their magiſtrates, we entruſt to the king and his council the higheſt power of executing the laws. This council ſhall be called *ſtraz*, or the council of inſpection. 131 Powers of the king and council of inſpection.

The duty of ſuch executive power ſhall be to watch over the laws, and to ſee them ſtrictly executed according to their import, even by the means of public force, ſhould it be neceſſary. All departments and magiſtracies are bound to obey its directions. To this power we leave the right of controling ſuch as are refractory, or of puniſhing ſuch as are negligent in the execution of their reſpective offices.

This executive power cannot aſſume the right of making laws, or of their interpretation. It is expreſsly forbidden to contract public debts; to alter the repartition of the national income, as fixed by the diet; to declare war; to conclude definitively any treaty, or any diplomatic act; it is only allowed to carry on negociations with foreign courts, and facilitate temporary occurrences, always with reference to the diet. 132

The crown of Poland we declare to be elective in regard to families, and it is ſettled ſo for ever. Crown elective in regard to families;

Having experienced the fatal effects of interregna, periodically

Poland.

periodically subverting government, and being desirous of preventing for ever all foreign influence, as well as of insuring to every citizen a perfect tranquillity, we have, from prudent motives, resolved to adopt hereditary succession to our throne: therefore we enact and declare, that, after the expiration of our life, according to the gracious will of the Almighty, the present elector of Saxony shall reign over Poland, and in his person shall the dynasty of future kings of Poland begin. We reserve to the nation, however, the right of electing to the throne any other house or family, after the extinction of the first.

133 But hereditary in each family till its extinction.

134 Coronation oath.

Every king, on his accession to the throne, shall take a solemn oath to God and the nation, to support the present constitution, to fulfil the *pacta conventa*, which will be settled with the present elector of Saxony, as appointed to the crown, and which shall bind him in the same manner as former ones.

135 King's person sacred:

The king's person is sacred and inviolable; as no act can proceed immediately from him, he cannot be in any manner responsible to the nation; he is not an absolute monarch, but the father and the head of the people; his revenues, as fixed by the *pacta conventa*, shall be sacredly preserved. All public acts, the acts of magistracies, and the coin of the kingdom, shall bear his name.

136 His particular powers.

The king, who ought to possess every power of doing good, shall have the right of pardoning those that are condemned to death, except the crimes be against the state. In time of war, he shall have the supreme command of the national forces: he may appoint the commanders of the army, however, by the will of the states. It shall be his province to patentee officers in the army, and other dignitaries, consonant to the regulations hereafter to be expressed, to appoint bishops, senators, and ministers, as members of the executive power.

137 Members of the council of inspection.

The king's council of inspection is to consist, 1. Of the primate, as the head of the clergy, and the president of the commission of education, or the first bishop in ordine. 2. Of five ministers, viz. the minister of police, minister of justice, minister of war, minister of finances, and minister for the foreign affairs. 3. Of two secretaries to keep the protocols, one for the council, another for the foreign department; both, however, without decisive vote. The hereditary prince coming of age, and having taken the oath to preserve the constitution, may assist at all sessions of the council, but shall have no vote therein. The marshal of the diet, being chosen for two years, has also a right to sit in this council, without taking any share in its resolves; for the end only to call together the diet, always existing, in the following case: should he deem, from the emergencies hereunder specified, the convocation of the diet absolutely necessary, and the king refusing to do it, the marshal is bound to issue his circular letters to all nuncios and senators, adducing real motives for such meeting.

138 Powers of the marshal.

The cases demanding such convocation of the diet are the following: 1. In a pressing necessity concerning the law of nations, and particularly in case of a neighbouring war. 2. In case of an internal commotion, menacing with the revolution of the country, or of a collision between magistratures. 3. In an evident danger of general famine. 4. In the orphan state of the country, by demise of the king, or in case of the king's dangerous illness. All the resolutions of the council of inspection are to be examined by the rules above mentioned. The king's opinion, after that of every member in the council has been heard, shall decisively prevail. Every resolution of this council shall be issued under the king's signature, countersigned by one of the ministers sitting therein; and thus signed, shall be obeyed by all executive departments, except in cases expressly exempted by the present constitution.

Should all the members refuse their countersign to any resolution, the king is obliged to forego his opinion; but if he should persist in it, the marshal of the diet may demand the convocation of the diet; and if the king will not, the marshal himself shall send his circular letters as above. Ministers composing this council cannot be employed at the same time in any other commission or department.

If it should happen that two thirds of secret votes in both houses demand the changing of any person, either in the council, or any executive department, the king is bound to nominate another. Willing that the council of inspection should be responsible to the nation for their actions, we decree, that when these ministers are denounced and accused before the diet (by the special committee appointed for examining their proceedings) of any transgression of positive law, they are answerable with their persons and fortunes. Such impeachments being determined by a simple majority of votes, collected jointly from both houses, shall be tried immediately by the comitial tribunal, where the accused are to receive their final judgment and punishment, if found guilty; or to be honourably acquitted on sufficient proof of innocence.

Com[missions of e]duca[tion and] poli[ce.]

In order to form a necessary organization of the executive power, we establish hereby separate commissions, connected with the above council, and subjected to obey its ordinations. These commissions are, 1. of education; 2. of police; 3. of war; 4. of treasury. It is through the medium of these four departments that all the particular orderly commissions (D), as established by the present diet, in every palatinate and district, shall depend on, and receive all orders from, the council of inspection, in their respective duties and occurrences.

Adm[ini]stra[tion of] justi[ce.]

The eighth article regulates the administration of justice, beginning with a very sensible declaration, that the judicial power is incompatible with the legislative, and that it cannot be administered by the king. It therefore constitutes primary courts of justice for each palatinate or district, composed of judges chosen at the dietine; and appoints higher tribunals, erected one in each of the three provinces into which the kingdom is divided, with which appeals may be lodged from the primary

(D) Orderly commissions are newly instituted; each palatinate and district chooses a certain number of commissaries; their office lasts two years; their principal duty is to maintain police and good order in their district; to put into execution decrees and regulations of supreme departments; to collect taxes; to keep cash; to make such payments as assigned by the commission of finances; to protect citizens from the military oppression; to furnish recruits, besides many other duties of internal management.

mary courts. It appoints likewise for the trial of persons accused of crimes against the state, one supreme general tribunal for all classes, called a *comitial tribunal* or court, composed of persons chosen at the opening of every diet. The ninth article provides a regency during the king's minority, in case of his settled alienation of reason, or upon the emergency of his being made a prisoner of war. This regency was to be composed of the council of inspection, with the queen at their head, or, in her absence, the primate of the kingdom. The tenth article enjoins, that the education of the king's sons shall be entrusted to the king with the council, and a tutor appointed by the states; and the eleventh regulates the army in such a manner, as to prevent it from being employed to overturn the constitution.

The regulation of the dietines contains nothing that can be interesting to a British reader, except what relates to the election and duties of nuncios or representatives to the general diet. And here it is enacted, that persons having a right to vote are all nobles of the equestrian order; *i. e.* 1. All hereditary proprietors of landed property, or possessed of estates by adjudication for a debt, paying territorial tax to government: sons also of such proprietors during the life of their parents, before the ex-division of patrimony. 2. Brothers inheriting estates before they have shared their succession. 3. All mortgages who pay 100 florins (50 shillings) of territorial tax per year from their possessions. 4. All life-holders of lands paying territorial tax to the same amount. 5. All nobles in the army possessed of such qualifying estates have a vote in their respective districts in time of peace, and properly furloughed by their commanders. 6. Legal possession is understood to be qualifying when it has been formerly acquired and actually enjoyed for twelve calendar months previously.

Persons who have no right to vote are, 1. Those of the equestrian order that are not actually possessed of a property, as described in the foregoing article. 2. Such as hold royal, ecclesiastical, or noble lands, even with right of inheritance, but on condition of some duty or payment to their principals, consequently dependent thereon. 3. Gentry possessing estates on feudal tenure, called *ordynackie*, as being bound to certain personal service thereby. 4. All renters of estates that have no other qualifying property. 5. Those that have not accomplished 18 years of age. 6. *Crimine notati*, and those that are under a decree passed in default, even in the first instance, for having disobeyed any judicial court.

Every person of the equestrian order that pays territorial tax to government for his freehold, let it be ever so small, is eligible to all elective offices in his respective district.

Gentlemen actually serving in the army, even possessed of landed hereditary estate, must have served six complete years before they are eligible to the office of a nuncio only. But this condition is dispensed with in favour of those that have filled before some public function.

Whoever is not personally present at the dietine; whoever has not completed 23 years of age; whoever has not been in any public function, nor passed the biennial office of a commissary in the orderly commission; those that are not exempted by law from obligations of *scarta bellatus*, which subjects all newly-nobilitated persons to certain civil restrictions until the next generation; and, lastly, all those against whom may be objected a decree *in contumaciam* in a civil cause; are not eligible.

Poland.

During the business of election, the president who opened the meeting, with the rest of the committee, except those who are assessors, shall prepare instructions for procedure; and in regard to the propositions sent by the king and the council of inspection, these instructions shall be worded thus: "Our nuncios shall vote *affirmative* to the article *N*;" or, "Our nuncios shall vote *negative* to the article *N*," in case it is found contrary to the opinion of the dietine: and should any amendment or addition be deemed necessary and agreed on, it may be inserted in the instructions at the end of the relative proposition.

144
Instructions to the nuncios,

At the meeting of the dietines, after the diet has sat, the nuncios are bound to appear before their constituents, and to bring their report of the whole proceedings of that assembly; first, respecting the acts of legislature; next, with respect to the particular projects of their palatinate or district recommended to them by the instructions.

145
Who are accountable to their constituents.

It is at these dietines that nuncios, after they have rendered to their constituents a clear account of their proceedings and of the diet, may be either confirmed or changed, and new ones elected in their stead till the general election for the following ordinary diet.

New nuncios are chosen, 1. In the room of the deceased. 2. In the room of those that are become senators or ministers of state. 3. In case of resignation. 4. In the room of such as are disqualified by the diet. 5. When any of the assembly desires a new election, to substitute another nuncio in the room of one expressly pointed out; which request must be made in writing, signed by 12 members besides, and be delivered to the marshal of the dietine. In this last case, the marshal is to read the name of the nuncio objected to, and to make the following proposition: "Shall the nuncio *N* be confirmed in his function? or, Shall there be a new election made in his stead?" The opinion of the meeting being taken by a division, the majority shall decide the question, and be declared by the marshal. If the majority approves the conduct of the nuncio, the marshal and the assessors shall certify this confirmation on the diploma; and in case of disapprobation, the marshal shall declare the vacancy, and begin the form of a new election.

146
This constitution, though superior to the former, protested against by some corrupt nobles,

Such are the outlines of the Polish constitution established by the king and the confederates in 1791. It will not bear a comparison with that under which Britons have the happiness to live; but it is surely infinitely superior to that motley form of government which, for a century past, has rendered Poland a perpetual scene of war, tumult, tyranny, and rebellion. Many of the corrupt nobles, however, perceiving that it would curb their ambition, deprive them of the base means which they had long enjoyed of gratifying their avarice by setting the crown to sale, and render it impossible for them to continue with impunity their tyrannical oppression of the peasants, protested against it, and withdrew from the confederates. This was nothing more than what might have been expected, or than what the king and his friends undoubtedly did expect. But the malcontents were not satisfied with a simple protest; they preferred their complaints to the empress of Russia,

Poland.

ſia, who, ready on all occaſions, and on the ſlighteſt pretence, to invade Poland, poured her armies into the
147 republic, and ſurrounding the king and the diet with ferocious ſoldiers, compelled them, by the moſt furious and indecent menaces, to undo their glorious labour of love, and to reſtore the conſtitution as ſettled after the partition treaty.

And oppoſed by the Ruſſians.

Of the progreſs of the Ruſſians in this work of darkneſs, our readers will be pleaſed with the following manly and indignant narrative, taken from a periodical work * of acknowledged merit.

* *New Annual Regiſter*, 1792.

" It was on the 21ſt of April 1792, that the diet received the firſt notification from the king, of the inimical and unjuſt intentions of Ruſſia. He informed them that, without the ſhadow of pretence, this avowed enemy of the rights of mankind had determined to invade the territory of the republic with an army of 60,000 men. This formidable banditti, commanded by generals Soltikow, Michelſon, and Koſakowſki, was afterwards to be ſupported by a corps of 20,000, and by the troops then acting in Moldavia, amounting to 70,000. The king, however, profeſſed that he was not diſcouraged, and declared his readineſs to put himſelf at the head of the national troops, and to terminate his exiſtence in a glorious conteſt for the liberties of his country. Then, and not before, the diet decreed the organiſation of the army, and its augmentation to 100,000. The king and the council of inſpection were inveſted with unlimited authority in every thing that regarded the defence of the kingdom. Magazines were ordered to be conſtructed when it was
148 too late, and quarters to be provided for the army.

The nation riſes to maintain its independence.

" The diet and the nation roſe as one man to maintain their independence. All private animoſities were obliterated, all private intereſts were ſacrificed; the greateſt encouragements were held forth to volunteers to enroll themſelves under the national ſtandard, and it was unanimouſly decreed by the diet, that all private loſſes ſhould be compenſated out of the public treaſury.

" On the 18th of May, the Ruſſian ambaſſador delivered a declaration, which was worthy of ſuch a cauſe. It was a tiſſue of falſehood and hypocriſy. It aſſerted, that this wanton invaſion, which was evidently againſt the ſenſe of almoſt every individual Polander, was meant entirely for the *good* of the republic. It cenſured the precipitancy with which the new conſtitution was adopted, and aſcribed the ready conſent of the diet to the influence of the Warſaw mob. It repreſented the conſtitution as a violation of the principles on which the Poliſh republic was founded—complained of the licentiouſneſs with which the *ſacred name of the empreſs* was treated in ſome ſpeeches of the members; and concluded by profeſſing, that on theſe accounts, and in behalf of the emigrant Poles, her imperial majeſty had ordered her troops to enter the territories of the republic.

" At the moment this declaration was delivered to the diet, the Ruſſian troops, accompanied by Counts Potocki, Rzewuſki, Branicki, and a few Poliſh apoſtates, appeared upon the frontiers, and entered the territories of
149 the republic in ſeveral columns, before the cloſe of the month. The ſpirit manifeſted by the nobility was truly honourable. Some of them delivered in their plate to the mint. Prince Radzvil engaged voluntarily to furniſh 10,000 ſtand of arms, and another a train of artillery. The courage of the new and haſtily embodied ſoldiers correſponded with the patriotiſm of their nobles. Prince Poniatowſki, nephew to the king, was appointed commander in chief; and though his force was greatly inferior to the enemy, it muſt be confeſſed that he made a noble ſtand. On the 24th of May, the enemy's Coſſacks were repulſed, and purſued by the patroles of the republic to the very entrenchments. On the 26th, about one o'clock, the piquets of the republic diſcovered a large body of Don Coſſacks approaching the outpoſts; and a ſquadron of cavalry, commanded by Lieutenant Kwaſniewſki, ſupported by Lieutenant Golejowſki with two ſquadrons more, in all about 300, marched out to meet them. They attacked the Coſſacks with ſucceſs, but purſued them with more valour than prudence to the ſide of a wood, where they found themſelves drawn into an ambuſcade, and ſurrounded by 2000 horſe, two battalions of chaſſeurs, and ſix pieces of cannon. The intrepid Poles bravely fought their way through the Ruſſian line, and killed upwards of 200 of the enemy. The Poles in this engagement loſt 100 men and two officers; one of whom, Lieutenant Kwaſniewſki, was wounded and made priſoner. The remainder of the detachment reached their quarters in ſafety.

Spirit of the nobility.

" Perhaps the hiſtory of man can ſcarcely furniſh an inſtance of perfidy, meanneſs, and duplicity, equal to that which was manifeſted by Pruſſia on this occaſion. By the treaty of defenſive alliance, ſolemnly contracted between the republic of Poland and the king of Pruſſia, and ratified on the 23d of April 1790, it is expreſſly ſtipulated, ' That the contracting parties ſhall do all in their power to guarantee and preſerve to each other reciprocally the whole of the territories which they reſpectively poſſeſs: That, in caſe of menace or invaſion from any foreign power, they ſhall aſſiſt each other with *their whole force*, if neceſſary :'—and by the ſixth article, it is further ſtipulated, ' that if any foreign power whatever ſhall preſume to interfere in the internal affairs of Poland, his Pruſſian majeſty ſhall conſider this as a caſe falling within the meaning of the alliance, and ſhall aſſiſt the republic according to the tenor of the fourth article," that is, with his *whole force*. What then is the pretext for abandoning this treaty? It is, that the *empreſs of Ruſſia has ſhown a decided oppoſition to the order of things eſtabliſhed in Poland on the third of May 1791, and is provoked by Poland preſuming to put herſelf into a poſture to defend it.*—It is known, however, by the moſt authentic documents, that nothing was effected on the third of May 1791, to which Pruſſia had not previouſly aſſented, and which ſhe did not afterwards ſanction; and that Pruſſia, according to the aſſertion of her own king, did not intimate a ſingle doubt reſpecting the revolution till one month (and according to the Pruſſian miniſter till ſix months) after it had taken place; in ſhort, to uſe the monarch's own words as fully explanatory of his double politics, " not till the *general tranquillity of Europe* permitted him to explain himſelf."——Inſtead, therefore, of aſſiſting Poland, Pruſſia inſultingly recommended to Poland to retrace her ſteps; in which caſe, ſhe ſaid that ſhe would be ready to *attempt an accommodation* in her favour. This attempt was never made, and probably never intended; for the empreſs purſued her meaſures.

The duchy of Lithuania was the great ſcene of action in the beginning of the war; but the Ruſſians had made little

Poland.

151 War with Russia.

little progreſs before the middle of the month of June. On the 10th of that month, General Judycki, who commanded a detachment of the Poliſh troops, between Mire and Swierzna, was attacked by the Ruſſians; but, after a combat of ſome hours, he obliged them to retire with the loſs of 500 men dead on the field.—The general was deſirous of profiting by this advantage, by purſuing the enemy, but was prevented by a moſt violent fall of rain. On the ſucceeding day, the Ruſſians rallied again to the attack; and it then too fatally appeared, that the Poles were too young and undiſciplined to contend with an inferior force againſt experienced troops and able generals. By a maſterly manœuvre, the Ruſſians contrived to ſurround their antagoniſts, at a moment when the Poliſh general ſuppoſed that he had obliged the enemy to retreat; and though the field was conteſted with the utmoſt valour by the troops of the republic, they were at length compelled to give way, and to retire towards Nieſwieſz.

On the 14th another engagement took place near Lubar, on the banks of the river Sluez, between a detachment of the Ruſſian grand army and a party of Poliſh cavalry, diſpatched by Prince Joſeph Poniatowſki, to intercept the enemy. The patriotic bravery of the Poles was victorious in this conteſt; but upon reconnoitering the force of the enemy, the prince found himſelf incapable of making a ſucceſsful ſtand againſt ſuch ſuperior numbers. He therefore gave orders to ſtrike the camp at Lubar, and commenced a precipitate retreat. During their march, the Poliſh rear was haraſſed by a body of 4000 Ruſſians, till arriving at Boruſkowee, the wooden bridge unfortunately gave way, under the weight of the cavalry. The enemy, in the mean time, brought their artillery to play upon the rear of the fugitives, who loſt upwards of 250 men. The Poliſh army next directed its courſe toward Zielime, where meeting, on the 17th, with a reinforcement from Zaflow, it halted to give battle to the enemy. The Ruſſians were upwards of 17,000 ſtrong, with 24 pieces of cannon, and the force of the republic much inferior. After a furious conteſt from ſeven in the morning till five in the afternoon, the Ruſſians were at length obliged to retreat, and leave the field of battle in poſſeſſion of the patriots. The Ruſſians were computed to have loſt 4000 men in this engagement, and the Poles about 1100.

Notwithſtanding theſe exertions, the Poles were obliged gradually to retire before their numerous and diſciplined enemies. Nieſwez, Wilna, Minſk, and ſeveral other places of leſs conſequence, fell into their hands one after another. On a truce being propoſed to the Ruſſian general Kochowſki, the propoſal was haughtily rejected; while the deſertion of vice brigadier Rudnicki and ſome others, who preferred diſhonour to perſonal danger, proclaimed a tottering cauſe. The progreſs of the armies of Catharine was marked with devaſtation and cruelty, while, ſuch was the averſion of the people both to the cauſe and the manner of conducting it, that, as they approached, the country all around became a wilderneſs, and ſcarcely a human being was to be ſeen.

In the mean time, a ſeries of little defeats, to which the inexperience of the commanders, and the intemperate valour of new raiſed troops, appear to have greatly contributed, ſerved at once to diſtreſs and to diſpirit theſe defenders of their country. Prince Poniatowſki continued to retreat, and on the 17th of July, his rear being attacked by a very ſuperior force, it ſuffered a conſiderable loſs, though the ſkill and courage of General Koſciuſko enabled him to make a moſt reſpectable defence. On the 18th, a general engagement took place between the two armies. The Ruſſian line extended oppoſite Dubienka, along the river Bog, as far as Opalin. The principal column, conſiſting of 14,000 men, was chiefly directed againſt the diviſion of General Koſciuſko, which conſiſted of 5000 men only. After a moſt vigorous reſiſtance, in which the Ruſſians loſt upwards of 4000 men, and the troops of the republic only ſome hundreds, the latter was compelled to give way before the ſuperior numbers of the enemy, and to retire further into the country.

152 The king propoſes ſubmiſſion.

This unequal conteſt was at laſt prematurely terminated. The king, whoſe benevolent intentions were, perhaps, overpowered by his mental imbecillity, and whoſe age and infirmities, probably, rendered him unequal to the difficulties and dangers which muſt attend a protracted war, inſtead of putting himſelf, according to his firſt reſolve, at the head of his army, determined, at once, to ſurrender at diſcretion. On the 23d of July, he ſummoned a council of all the deputies at that moment in Warſaw. He laid before them the laſt diſpatches from the empreſs, which inſiſted upon total and unreſerved ſubmiſſion. He pointed out the danger of a diſmemberment of the republic, ſhould they delay to throw themſelves upon the clemency of the empreſs, and to intreat her protection. He mentioned the fatal union of Auſtria and Pruſſia with Ruſſia; and the diſgraceful ſupineneſs manifeſted by every other court in Europe.

Four citizens, the intrepid and patriotic Malachowſki, the princes Sapieha, Radzvil, and Soltan, vehemently proteſted againſt theſe daſtardly proceedings; and the following evening a company of gentlemen from the different provinces aſſembled for the ſame purpoſe. The aſſembly waited immediately on theſe four diſtinguiſhed patriots, and returned them their acknowledgements for the ſpirit and firmneſs with which they had reſiſted the uſurpations of deſpotiſm. The ſubmiſſion of the king to the deſigns of Ruſſia was no ſooner made known, than Poland was bereft of all her beſt and moſt reſpectable citizens. Malachowſki as marſhal of the diet, and Prince Sapieha grand marſhal of Lithuania, entered ſtrong proteſts on the journals of the diet againſt theſe hoſtile proceedings, and declared ſolemnly that the diet legally aſſembled in 1788 was not diſſolved.

153 Confederation at Warſaw overawed by Ruſſia, reſtores the former conſtitution.

On the ſecond of Auguſt a confederation was formed at Warſaw, of which the grand apoſtate, Potocki, was choſen Marſhall. The acts of this confederation were evidently the deſpotic dictates of Ruſſia, and were calculated only to reſtore the ancient abuſes, and to place the country under the aggravated oppreſſion of a foreign yoke.

It is remarkable, that at the very moment when Poland was ſurrendering its liberties to its deſpotic invaders, the generous ſympathy of Great Britain was evinced by a liberal ſubſcription, ſupported by all the moſt reſpectable characters in the nation, of every party and of every ſect, for the purpoſe of aſſiſting the king and the republic to maintain their independence. Though the

Poland.

the benevolent defign was fruftrated, the fact remains on record as a noble teftimony of the fpirit of Britons in the caufe of freedom, of the indignation which fills every Britifh heart at the commiffion of injuftice, and of the liberality with which they are difpofed to affift thofe who fuffer from the oppreffion of tyrants.

154 The emprefs feizes upon part of the Polifh territory.

Not fatisfied with reftoring the old wretched conftitution, the emprefs of Ruffia feized upon part of the territory which, at the laft partition, fhe and her coadjutors had left to the republic; and her ambaffador entering into the diet with a crowd of armed ruffians, compelled the king and that affembly to grant the form of legality to her ufurpations. The nation, however, did not fubmit. General Kofciufko kept together a few retainers, whom he was foon enabled to augment to the number of an army; and feizing on the perfon of the king, he has ever fince waged againft Ruffia a war, of which, it muft be confeffed, the object is doubtful. His enemies accufe him of cherifhing in the republic the principles of the French Jacobins; and fome late occurrences give a countenance to the accufation. Yet it is known he protefted at firft that his aim reached no farther than to reftore the conftitution of 1791; and if public report may be credited, an infurrection has lately taken place in Great Poland, or South Pruffia, in favour of that conftitution. If other Poles have been driven to democracy, they have only, with the common weaknefs of human nature, run from one extreme to another; and in flying from the tyranny of their invaders, have fallen into the horrors of anarchy. That Kofciufko will fucceed againft the powerful empire of Ruffia, there is not the fmalleft probability; and if there were, the court of Berlin, to complete its character, has withdrawn from the moft honourable alliance in which it was ever engaged, and feems to have employed the fubfidy which it received from Great Britain for the maintenance of that alliance, to co-operate with the emprefs in annihilating the kingdom and republic of Poland. What will be the ultimate fate of that unhappy country, and its amiable fovereign, it is impoffible to fay; but appearances at prefent indicate a divifion of the whole territory among the three hoftile powers who formerly robbed it of fome of its moft valuable provinces; and when that divifion is made, the virtuous Staniflaus may be removed to a better world by the dagger, by the bowl, by the gripe of a giant, or by a red-hot fpit!

155 Deplorable ftate of the country.

156 Air, climate, &c. of Poland.

The air of this kingdom is cold in the north, but temperate in the other parts both in fummer and winter, and the weather in both more fettled than in many other countries. The face of the country is for the moft part level, and the hills are but few. The Crapack or Carpathian mountains feparate it from Hungary on the fouth. The foil is very fruitful both in corn and pafturage, hemp and flax. Such is the luxuriance of the paftures in Podolia, that it is faid one can hardly fee the cattle that are grazing in the meadows. Vaft quantities of corn are yearly fent down the Viftula to Dantzic, from all parts of Poland, and bought up chiefly by the Dutch. The eaftern part of the country is full of woods, forefts, lakes, marfhes, and rivers; of the laft of which, the moft confiderable in Poland are, the Viftula, Nieper, Niefter, Duna, Bog, Warta, and Memel. The metals found in this country are iron and lead, with fome tin, gold, and filver; but there are no mines of the two laft wrought at prefent. The other products of Poland are moft forts of precious ftones, ochre of all kinds, fine rock-cryftal; Mufcovy glafs, talc, alum, faltpetre, amber, pitcoal, quickfilver, fpar, fal-gem, lapis calaminaris, and vitriol. In Leffer Poland are falt-mines, which are the chief riches of the country, and bring moft money into the exchequer. In the woods, which confift moftly of oak, beech, pine, and fir-trees, befides the more common wild beafts, are elks, wild affes, wild oxen or uri, lynxes, wild horfes, wild fheep with one horn, bifons, hyænas, wild goats, and buffaloes. In the meadows and fenny ground is gathered a kind of manna; and the kermes-berries produced in this country are ufed both in dying and medicine.

157 Different claffes of inhabitants.

The inhabitants confift of nobles, citizens, and peafants. The firft poffefs great privileges, which they enjoy partly by the indulgence of their kings, and partly by ancient cuftom and prefcription. Some of them have the title of *prince*, *count*, or *baron*; but no fuperiority or pre-eminence on that account over the reft, which is only to be obtained by fome public poft or dignity. They have the power of life and death over their vaffals; pay no taxes; are fubject to none but the king; have a right to all mines and falt-works on their eftates; to all offices and employments, civil, military, and ecclefiaftic; cannot be cited or tried out of the kingdom; may choofe whom they will for their king, and lay him under what reftraints they pleafe by the Pacta Conventa; and none but they and the burghers of fome particular towns can purchafe lands. In fhort, they are almoft entirely independent, enjoying many other privileges and prerogatives befides thofe we have fpecified; but if they engage in trade, they forfeit their nobility.

158 Language.

The Polifh tongue is a dialect of the Sclavonic: (fee PHILOLOGY, n° 222.). It is neither copious nor harmonious. Many of the words, as they are written, have not a fingle vowel in them; but the High Dutch and Latin are underftood and fpoken pretty commonly, though incorrectly. The language in Lithuania differs much from that of the other provinces. True learning, and the ftudy of the arts and fciences, have been little attended to in Poland, till of late they began to be regarded with a more favourable eye, and to be not only patronized, but cultivated by feveral of the nobles and others, both laymen and ecclefiaftics.

159 Archbifhoprics, &c.

There are two archbifhops in the kingdom, viz. thofe of Gnefna and Laopol, and about a dozen bifhops. The archbifhop of Gnefna is always a cardinal, and primate of the kingdom. The prevailing religion is Popery, but there are great numbers of Lutherans, Calvinifts, and Greeks, who are called *Diffidents*, and by the laws of the kingdom were intitled to toleration; but were much oppreffed till very lately. The Jews are indulged with great privileges, and are very numerous in Poland; and in Lithuania, it is faid there are a multitude of Mahometan Tartars. We may judge of the numbers of Jews in this country by the produce of their annual poll-tax, which amounts to near 57,000 rixdollars.

160 Manufactures.

There are few or no manufactures in the kingdom, if we except fome linen and woollen clothes and hardwares; and the whole trade is confined to the city of Dantzic, and other towns on the Viftula or Baltic.

161 Revenue.

Before the prefent troubles the king's revenue was all

5

Poland || Pole.

all clear to himſelf; for he paid no troops, not even his own guards; but all the forces, as well as the officers of ſtate, were paid by the republic. The public revenues aroſe chiefly from the crown-lands, the ſalt-mines in the palatinate of Cracow, from the rents of Marienburg, Dirſhau, and Regenhus, from the government of Cracow, and diſtrict of Niepolomiez, and from ancient tolls and cuſtoms, particularly thoſe of Elbing and Dantzic. From what ſources thoſe revenues now ariſe, it is difficult to ſay; but Pruſſia has got poſſeſſion of the
162 moſt lucrative cuſtoms.

...er of ...ht... ...d.

The order of the White Eagle was inſtituted by Auguſtus II. in the year 1705. Its enſign is a croſs of gold enamelled with red, and appendant to a blue ribbon. The motto, *Pro fide, rege, et lege.*

163 ...es.

The ſtanding forces of Poland are divided into the crown-army, and that of Lithuania, conſiſting of horſe and foot, and amounting to between 20,000 and 30,000 men. Theſe troops are moſtly cantoned on the crown-lands, and in Poland are paid by a capitation or poll-tax; but in Lithuania other taxes are levied for this purpoſe. Moſt of the foot are Germans. On any ſudden and imminent danger, the whole body of the nobility, with their vaſſals, are obliged to appear in the field on horſeback; and the cities and towns furniſh a certain number of foot-ſoldiers, with carriages, and military ſtores: but for want of proper arms, proviſions, ſubordination, and diſcipline, and by being at liberty after a few weeks to return home, this body has proved but of little advantage to the republic. Dantzic is the only place in the Poliſh dominions that deſerves the name of a fortreſs, and it is now in the poſſeſſion of Pruſſia. Foreign auxiliaries are not to be brought into the kingdom, nor the national troops to march out of it, without the conſent of the ſtates.

Such was the military eſtabliſhment of Poland before the partition treaty. What it has been ſince, and
164 is at preſent, we cannot poſitively ſay.

...racter ...e ...le.

The Poles are perſonable men, and have good complexions. They are eſteemed a brave, honeſt people, without diſſimulation, and exceedingly hoſpitable. They clothe themſelves in furs in winter, and over all they throw a ſhort cloak. No people keep grander equipages than the gentry. They look upon themſelves as ſo many ſovereign princes; and have their guards, bands of muſic, and keep open houſes: but the lower ſort of people are poor abject wretches, in the loweſt ſtate of ſlavery. The exerciſes of the gentry are hunting, riding, dancing, vaulting, &c. They reſide moſtly upon their eſtates in the country; and maintain themſelves and families by agriculture, breeding of bees, and grazing.

POLAR, in general, ſomething relating to the poles of the world, or poles of the artificial globes.

Polar Regions, thoſe parts of the world which lie near the north and ſouth poles. See the article Pole.

POLARITY, the quality of a thing conſidered as having poles, or a tendency to turn itſelf into one certain poſture; but chiefly uſed in ſpeaking of the magnet.

POLE (Reginald), cardinal, and archbiſhop of Canterbury, a younger ſon of Sir Rich. Pole, Lord Montague, was born at Stoverton caſtle, in Staffordſhire, in the year 1500. At ſeven years of age he was ſent to a Carthuſian monaſtery at Shene, near Richmond in Surry; and thence, when he was about 12 years old, removed to Magdalen college in Oxford, where, by the inſtructions of the celebrated Lineacre and Latimer, he made conſiderable progreſs in learning. In 1515 he took the degree of bachelor of arts, and was admitted to deacon's orders ſome time after: in 1517, he was made prebendary of Saliſbury, and in 1519 dean of Wimborne and dean of Exeter. We are not ſurpriſed at this young nobleman's early preferments, when we conſider him as the kinſman of Henry VIII. and that he was bred to the church by the king's ſpecial command.

Pole.

Being now about the age of 19, he was ſent, according to the faſhion of the times, to finiſh his ſtudies at Padua in Italy, where he reſided ſome time in great ſplendor, having a handſome penſion from the king. He returned to England in 1525, where he was moſt graciouſly received at court, and univerſally admired for his talents and addreſs; but preferring ſtudy and ſequeſtration to the pleaſures of a court, he retired to the Carthuſian convent at Shene, where he had continued about two years, when the pious king began to divulge his ſcruples of conſcience concerning his marriage with Catharine of Spain. Pole foreſaw that this affair would neceſſarily involve him in difficulties; he therefore determined to quit the kingdom, and accordingly obtained leave to viſit Paris. Having thus avoided the ſtorm for the preſent, he returned once more to his convent at Shene; but his tranquillity was again interrupted by the king's reſolution to ſhake off the pope's ſupremacy, of which Pole's approbation was thought indiſpenſably neceſſary. How he managed in this affair, is not very clear. However, he obtained leave to reviſit Italy, and his penſion was continued for ſome time.

The king, having now divorced Queen Catharine, married Anne Boleyn, and being reſolved to throw off the papal yoke, ordered Dr Richard Sampſon to write a book in juſtification of his proceedings, which he ſent to Pole for his opinion. To this Pole, ſecure in the pope's protection, wrote a ſcurrilous anſwer, entitled *Pro Unitate Eccleſiaſtica*, and ſent it to the king; who was ſo offended with the contents, that he withdrew his penſion, ſtripped him of all his preferments, and procured an act of attainder to be paſſed againſt him. In the mean time, Pole was created a cardinal, and ſent nuncio to different parts of Europe. King Henry made ſeveral attempts to have him ſecured and brought to England, but without effect. At length the pope fixed him as legate at Viterbo, where he continued till the year 1543, when he was appointed legate at the council of Trent, and was afterwards employed by the pope as his chief counſellor.

Pope Paul III. dying in 1549, Pole was twice elected his ſucceſſor, and, we are told, twice refuſed the papal dignity: firſt, becauſe the election was made in too great haſte; and the ſecond time, becauſe it was done in the night. This delicacy in a cardinal is truly wonderful: but the intrigues of the French party ſeem to have been the real cauſe of his miſcarriage; they ſtarted many objections to Pole, and by that means gained time to procure a majority againſt him. Cardinal Maria de Monte obtained the triple crown; and Pole, having kiſſed his ſlipper, retired to the convent of Magazune near Verona, where he continued till the death of Edward VI. in the year 1553. On the acceſſion of queen Mary, Pole was ſent legate to England, where he was received by her majeſty with great veneration, and con-

ducted

Pole.

ducted to the archbishop's palace at Lambeth, poor Cranmer being at that time prisoner in the Tower. He immediately appeared in the House of Lords, where he made a long speech; which being reported to the commons by their speaker, both these obsequious houses concurred in an humble supplication to be reconciled to the see of Rome. They presented it on their knees to her majesty, who interceded with the cardinal, and he graciously condescended to give them absolution. This business being over, the legate made his public entry into London, and immediately set about the extirpation of heresy. The day after the execution of Cranmer, which he is said, though we believe falsely, to have advised, he was consecrated archbishop of Canterbury. In the same year, 1556, he was elected chancellor of the university of Oxford, and soon after of Cambridge; both which he visited, by his commissioners. He died of a double quartan ague in the year 1558, about 16 hours after the death of the queen; and was buried in the cathedral of Canterbury.

As to his character, the Romish writers ascribe to him every virtue under heaven: even Bishop Burnet is extremely lavish in his praise, and attributes the cruelties of Mary's reign to the advice of Gardiner. In this Mr Hume agrees with the bishop, and represents Pole as the advocate of toleration. By every impartial account, he seems to have been a man of mild manners, and of real worth, though undoubtedly a zealous member of the church of Rome.—He wrote, *Pro unitate ecclesiastica*, *De ejusdem potestate*, A treatise on Justification, and various other tracts.

Mr Philips published a very well written, though a very partial account, of Pole's life, to which Glocester Ridley replied. This last work, which is entitled a *Review of Mr Philips's Life of Reginald Pole*, was published in 1766. It is a complete confutation of the former, and is a very learned and temperate vindication of the doctrines of the Reformation.

Pole, in astronomy, that point in the heavens round which the whole sphere seems to turn. It is also used for a point directly perpendicular to the centre of any circle's plane, and distant from it by the length of a radius.

Pole, in geography, one of the points on which the terraqueous globe turns; each of them being 90 degrees distant from the equator, and, in consequence of their situation, the inclination of the earth's axis, and its parallelism during the annual motion of our globe round the sun, having only one day and one night throughout the year.

1 The poles enjoy much light;

It is remarkable, that though the *north* in Hebrew, Greek, Latin, and French, derives its name from gloom, obscurity, and darkness, the poles enjoy more light than any other part of the world. The ancients believed the north to be covered with thick darkness; Strabo tells us, that Homer, by the word σοφος, which properly signifies *obscurity* or *darkness*, meant the *north*; and thus Tibullus, speaking of the north, says,

Illic et densa tellus absconditur umbra.
Paneg. ad Missel.

The Arabians call the northern ocean the *dark sea*; the Latins gave the name of *Aquilo* to the north wind, because *aquilus* signifies *black*; and the French call it *la bise*, from *bis* "black." According to the ancients, the Cimmerians lived in darkness, because they were placed near the north. But all this is mere prejudice; for there are no places in the world that enjoy light longer than the arctic and antarctic poles; and this is accounted for by considering the nature of twilight. In the torrid zone, and under the line, night immediately follows the setting of the sun, without any sensible twilight; whereas the twilight begins and continues increasing in proportion as places are distant from the equator or approach the pole. To this long twilight we must add the *aurora borealis*, which appears in the northern regions, Greenland, &c. in clear nights, at the beginning of the new moon, casting a light equal to that of full moon. See Gassendi *in the life of Peyresc*, book iii. and La Perere in his *Account of Greenland*. There is also long moonlight at the poles during winter. See Astronomy, n° 373. But though there is really more light in the polar regions than elsewhere, yet owing to the obliquity with which the rays of the sun fall upon them, and the great length of winter night, the cold is so intense, that those parts of the globe which lie near the poles have never been fully explored, though the attempt has been repeatedly made by the most celebrated navigators. Indeed their attempts have chiefly been confined to the northern regions; for with regard to the south pole, there is not the same incitement to attempt it. The great object for which navigators have ventured themselves in these frozen seas, was to find out a more quick and more ready passage to the East Indies*; and this hath been attempted three several ways: one by coasting along the northern parts of Europe and Asia, called the *north-east passage*; another, by sailing round the northern part of the American continent, called the *north-west passage*; and the third, by sailing directly over the pole itself.

2 And wh[illegible]

* See [illegible] p. 395. col. 2.

We have already given a short account of several unsuccessful attempts which have been made from England to discover the first two of these. See North-West Passage, and North-East Passage. But before we proceed to the third, we shall make a few further observations on them, and mention the attempts of some other nations.

3 Attemp[ts] to find the nor[th-]east passage.

During the last century, various navigators, Dutchmen particularly, attempted to find out the *north-east passage*, with great fortitude and perseverance. They always found it impossible, however, to surmount the obstacles which nature had thrown in the way. Subsequent attempts are thought by many to have demonstrated the impossibility of ever sailing eastward along the northern coast of Asia; and this impossibility is accounted for by the increase of cold in proportion to the extent of land. See America, n° 3—5. This is indeed the case in temperate climates; but much more so in those frozen regions where the influence of the sun, even in summer, is but small. Hence, as the continent of Asia extends a vast way from west to east, and has besides the continent of Europe joined to it on the west, it follows, that about the middle part of that tract of land the cold should be greater than anywhere else. Experience has determined this to be fact; and it now appears, that about the middle part of the northern coast of Asia the ice never thaws; neither have even the hardy Russians and Siberians themselves been able to overcome the difficulties they met with in that part of their voyage. In order to make this the more plain and

4 Why i[t is] impossi[ble] to sail [a]long th[e] north-[east] coast o[f] Asia.

and the following accounts more intelligible, we ſhall obſerve, that from the north-weſtern extremity of Europe, called the *North Cape*, to the north-eaſtern extremity of Aſia, called the *Promontory of the Tſchutſki**, is a ſpace including about 160 degrees of longitude, *viz.* from 40 to 200 eaſt from Ferro: the port of Archangel lies in about 57 degrees eaſt longitude, Nova Zembla between 70 and 95; which laſt is alſo the ſituation of the mouth of the great river Oby. Still farther eaſtward are the mouths of the rivers Jeniſey in 100°; Piaſida in 105°; Chatanga in 124°; Lena, which has many mouths, between 134° and 142°; Indigirka in 162°; and the Kovyma in 175°. The coldeſt place in all this tract, therefore, ought to be that between the mouths of the Jeniſey and the Chatanga; and indeed here the unſurmountable difficulty has always been, as will appear from the following accounts of the voyages made by the Ruſſians with a view to diſcover the north-eaſt paſſage.

In 1734, lieutenant Morzovieff ſailed from Archangel towards the river Oby, but could ſcarce advance 20 degrees of longitude during that ſeaſon. The next ſummer he paſſed through the ſtraits of Weygatz into the ſea of Kara; but did not double the promontory which ſeparates the ſea of Kara from the bay or mouth of Oby. In 1738, the lieutenants Malgyin and Shurakoff doubled that promontory with great difficulty, and entered the bay of Oby. Several unſucceſsful attempts were made to paſs from the bay of Oby to the Jeniſey; which was at laſt effected, in 1738, by two veſſels commanded by lieutenants Offzin and Koſkeleff. The ſame year the pilot Feodor Menin ſailed eaſtwards from the Jeniſey to the mouth of the Piaſida: but here he was ſtopped by the ice; and finding it impoſſible to force a paſſage, he returned to the Jeniſey.

In July 1735, lieutenant Prontſhiſtcheff ſailed down the river Lena, in order to paſs by ſea to the mouth of the Jeniſey. The weſtern mouths of the Lena were ſo choaked up with ice, that he was obliged to paſs thro' the moſt eaſterly one; and was prevented by contrary winds from getting out till the 13th of Auguſt. Having ſteered north-weſt along the iſlands which lie ſcattered before the mouths of the Lena, he found himſelf in lat. 70. 4.; yet even here he ſaw pieces of ice from 24 to 60 feet in height, and in no place was there a free channel left of greater breadth than 100 or 200 yards. His veſſel being much damaged, he entered the mouth of the Olenek, a ſmall river near the weſtern mouth of the Lena; and here he continued till the enſuing ſeaſon, when he got out in the beginning of Auguſt. But before he could reach the mouth of the Chatanga, he was ſo entirely ſurrounded and hemmed in with ice, that it was with the utmoſt difficulty he could get looſe. Obſerving then a large field of ice ſtretching into the ſea, he was obliged to ſail up the Chatanga. Getting free once more, he proceeded northward, doubled the cape called *Taimura*, and reached the bay of that name, lying in about 115° eaſt from Ferro; from thence he attempted to proceed weſtward along the coaſt. Near the ſhore were ſeveral ſmall iſlands, between which and the ſhore the ice was immoveably fixed. He then directed his courſe towards the ſea, in order to paſs round the chain of iſlands. At firſt he found the ſea more free to the north of theſe iſlands, but obſerved much ice lying between them. At laſt he arrived at what he took to be the laſt of the iſlands, lying in lat. 77. 25. Between this iſland and the ſhore, as well as on the other ſide of the iſland which lay moſt to the north, the ice was firm and immoveable. He attempted, however, to ſteer ſtill more to the north; and having advanced about ſix miles, he was prevented by a thick fog from proceeding: this fog being diſperſed, he ſaw nothing everywhere but ice, which at laſt drove him eaſtward, and with much danger and difficulty he got to the mouth of the Olenek on the 29th of Auguſt.

7 Of Chariton Laptieff.

Another attempt to paſs by ſea from the Lena to the Jeniſey was made in 1739 by Chariton Laptieff, but with no better ſucceſs than that juſt mentioned. This voyager relates, that between the rivers Piaſida and Taimura, a promontory ſtretches into the ſea, which he could not double, the ſea being entirely frozen up before he could paſs round.

8 Mr Coxe's obſervations.

Beſides the Ruſſians, it is certain that ſome Engliſh and Dutch veſſels have paſſed the iſland of Nova Zembla into the ſea of Kara: "But (ſays Mr Coxe in his Account of the Ruſſian voyages) no veſſel of any nation has ever paſſed round that cape which extends to the north of the Piaſida, and is laid down in the Ruſſian charts in about 78° lat. We have already ſeen that no Ruſſian veſſel has ever got from the Piaſida to the Chatanga, or from the Chatanga to the Piaſida; and yet ſome authors have poſitively aſſerted that this promontory has been ſailed round. In order therefore to elude the Ruſſian accounts, which clearly aſſert the contrary, it is pretended that Gmelin and Muller have purpoſely concealed ſome parts of the Ruſſian journals, and have impoſed on the world by a miſrepreſentation of facts. But without entering into any diſpute upon this head, I can venture to affirm, that no ſufficient proof has been as yet advanced in ſupport of this aſſertion; and therefore, until ſome poſitive information ſhall be produced, we cannot deny plain facts, or give the preference to hearſay evidence over circumſtantial and well atteſted accounts."

9 Of the navigation from the Lena to Kamſchatka.

The other part of this north-eaſt paſſage, *viz.* from the Lena, to Kamſchatka, though ſufficiently difficult and dangerous, is yet practicable; as having been once performed, if we may believe the accounts of the Ruſſians. According to ſome authors indeed, ſays Mr Coxe, this navigation has been open a century and an half; and ſeveral veſſels at different times have paſſed round the north-eaſtern extremity of Aſia. But if we conſult the Ruſſian accounts, we ſhall find that frequent expeditions have been unqueſtionably made from the Lena to the Kovyma, but that the voyage from the Kovyma round Tſchutſkoi Noſs into the Eaſtern Ocean has been performed but once. According to Mr Muller, this formidable cape was doubled in the year 1648. The material incidents of this remarkable voyage are as follow.

10 Voyage of Deſhneff, Ankudinoff, &c.

"In 1648 ſeven kotches, or veſſels, ſailed from the mouth of the river Kovyma, in order to penetrate into the Eaſtern Ocean. Of theſe, four were never more heard of: the remaining three were commanded by Simon Deſhneff, Geraſim Ankudinoff, and Fedot Alexeeff. Deſhneff and Ankudinoff quarrelled before their departure concerning the diviſion of profits and honours to be acquired by their voyage; which, however, was not ſo eaſily accompliſhed as they had imagined. Yet

Pole.

Deshneff in his memorials makes no mention of obstructions from the ice, nor probably did he meet with any; for he takes notice that the sea is not every year so free from ice as it was at that time. The vessels sailed from the Kovyma on the 20th of June, and in September they reached the promontory of the Tschutski, where Ankudinoff's vessel was wrecked, and the crew distributed among the other two. Soon after this the two vessels lost sight of each other, and never joined again. Deshneff was driven about by tempestuous winds till October, when he was shipwrecked considerably to the south of the Anadyr. Having at last reached that river, he formed a scheme of returning by the same way that he had come; but never made the attempt. As for Alexeeff, after being also shipwrecked, he had died of the scurvy, together with Ankudinoff; part of the crew were killed by the savages, and a few escaped to Kamschatka, where they settled."

* See Cook's *Discoveries*, n° 95—100.

From Captain* Cook's voyage towards the north-eastern parts of Asia, it appears, that it is possible to double the promontory of Tschutski without any great difficulty: and it now appears, that the continents of Asia and America are separated from one another but by a narrow strait, which is free from ice; but, to the northwards, that experienced navigator was everywhere stopped by ice in the month of August, so that he could neither trace the American continent farther than to the latitude of 70°, nor reach the mouth of the river Kovyma on the Asiatic continent; though it is probable that this might have been done at another time when the situation of the ice was altered either by winds or currents.

11 Insurmountable obstacles in the north-east passage.

On the whole, therefore, it appears that the insurmountable obstacle in the north-east passage lies between the rivers Piasida and Chatanga; and unless there be in that space a connection between the Asiatic and American continents, there is not in any other part. Ice, however, is as effectual an obstruction as land: and though the voyage were to be made by accident for once, it never could be esteemed a passage calculated for the purposes of trade, or any other beneficial purpose whatever.

12 Of the north-west passage.

With regard to the north-west passage, the same difficulties occur as in the other. Captain Cook's voyage has now assured us, that if there is any strait which divides the continent of America into two, it must lie in a higher latitude than 70°, and consequently be perpetually frozen up. If a north-west passage can be found then, it must be by sailing round the whole American continent, instead of seeking a passage through it, which some have supposed to exist in the bottom of Baffin's Bay. But the extent of the American continent to the northward is yet unknown; and there is a possibility of its being joined to that part of Asia between the Piasida and Chatanga, which has never yet been circumnavigated* It remains therefore to consider, whether there is any possibility of attaining the wished for passage by sailing directly north, between the eastern and western continents.

* See Cook's *Discoveries*, n° 11.

13 Barrington's arguments in favour of a possibility of reaching the pole.

Of the practicability of this method, the Honourable Daines Barrington is very confident, as appears by several tracts which he published in the years 1775 and 1776, in consequence of the unsuccessful attempts made by Captain Phipps, now Lord Mulgrave. See *North-East Passage*, p. 108. col. 1. top of the page.—In these tracts he instances a great number of navigators who have reached very high northern latitudes; nay, some who have been at the pole itself, or gone beyond it.—These instances are, 1. One Captain Thomas Robertson assured our author, that he had been in latitude $82\frac{1}{2}$, that the sea was open, and he was certain that he could have reached the latitude of 83°.—2. From the testimony of Captain Cheyne, who gave answers to certain queries drawn up by Mr Dalrymple concerning the polar seas, it appears that he had been in the latitude of 82°.—3. One Mr Watt informed our author, that when he was 17 years of age, at that time making his first voyage with Captain M'Callam, a bold and skilful navigator, who commanded a Scotch whale-fishing ship, as during the time that the whales are supposed to copulate no fishing can be carried on, the captain resolved to employ that interval in attempting to reach the north pole. He accordingly proceeded without the least obstruction to $83\frac{1}{2}$, when the sea was not only open to the northward, but they had seen no ice for the last three degrees; but while he still advanced, the mate complained that the compass was not steady, and the captain was obliged with reluctance to give over his attempt.—4. Dr Campbell, the continuator of Harris's voyages, informed Mr Barrington, that Dr Dallie, a native of Holland, being in his youth aboard a Dutch ship of war which at that time was usually sent to superintend the Greenland fishery, the captain determined, like the Scotchman above-mentioned, to make an attempt to reach the pole during the interval between the first and second fisheries. He penetrated, according to the best of Dr Campbell's recollection, as far as 88°; when the weather was warm, the sea free from ice, and rolling like the bay of Biscay. Dallie now pressed the captain to proceed: but he answered, that he had already gone too far, and should be blamed in Holland for neglecting his station; upon which account he would suffer no journal to be kept, but returned as soon as possible to Spitsbergen.—5. In the year 1662-3, Mr Oldenburg, then secretary of the Royal Society, was ordered to register a paper, entitled "Several inquiries concerning Greenland, answered by Mr Gray, who had visited these parts." The 19th of these queries is the following: How near hath any one been known to approach the pole?—The answer is, "I once met upon the coast of Greenland a Hollander that swore he had been half a degree from the pole, showing me his journal, which was also attested by his mate; where they had seen no ice or land, but all water."—6. In Captain Wood's account of a voyage in quest of the north-east passage, we have the following account of a Dutch ship which reached the latitude of 89°. "Captain Goulden, who had made above 30 voyages to Greenland, did relate to his majesty, that being at Greenland some 20 years before, he was in company with two Hollanders to the eastward of Edge's island; and that the whales not appearing on the shore, the Hollanders were determined to go farther northward; and in a fortnight's time returned, and gave it out that they had sailed into the latitude 89°, and that they did not meet with any ice, but a free and open sea, and that there run a very hollow *grown* sea like that of the Bay of Biscay. Mr Goulden being not satisfied with the bare relation, they produced him four journals out of the two ships, which testified the same, and that they all agreed within four minutes."

minutes."—7. In the Philosophical Transactions for 1675 we have the following passage: "For it is well known to all that sail northward, that most of the northern coasts are frozen up for many leagues, though in the open sea it is not so, *no nor under the pole itself*, unless by accident." In which passage the having reached the pole is alluded to as a known fact, and as such stated to the Royal Society.—8. Mr Miller, in his Gardener's Dictionary, mentions the voyage of one Captain Johnson, who reached 88 degrees of latitude. Mr Barrington was at pains to find a full account of this voyage; but met only with the following passage in Buffon's Natural History, which he takes to be a confirmation of it. "I have been assured by persons of credit, that an English captain, whose name was Monson, instead of seeking a passage to China between the northern countries, had directed his course to the pole, and had approached it within two degrees, where there was an open sea, without any ice." Here he thinks that Mr Buffon has mistaken Johnson for Monson.—9. A map of the northern hemisphere, published at Berlin (under the direction of the Academy of Sciences and Belles Letters), places a ship at the pole, as having arrived there according to the Dutch accounts.—10. Moxon, hydrographer to Charles II. gives an account of a Dutch ship having been two degrees beyond the pole, which was much relied on by Wood. This vessel found the weather as warm there as at Amsterdam.

Besides these, there are a great number of other testimonies of ships which have reached the lat. of 81, 82, 83, 84 (A), &c.; from all which our author concludes, that if the voyage is attempted at a proper time of the year, there would not be any great difficulty of reaching the pole. Those vast pieces of ice which commonly obstruct the navigators, he thinks, proceed from the mouths of the great Asiatic rivers which run northward into the frozen ocean, and are driven eastward and westward by the currents. But though we should suppose them to come directly from the pole, still our author thinks that this affords an undeniable proof that the pole itself is free from ice; because, when the pieces leave it, and come to the southward, it is impossible that they can at the same time accumulate at the pole.

Pole.

14 Why we cannot suppose the sea all round the pole to be frozen.

The extreme cold of the winter air on the continents of Asia and America has afforded room for suspicion, that at the pole itself, and for several degrees to the southward of it, the sea must be frozen to a vast depth in one solid cake of ice; but this Mr Barrington refutes from several considerations. In the first place, he says, that on such a supposition, by the continual intensity of the cold, and the accumulation of snow and frozen vapour, this cake of ice must have been increasing in thickness since the creation, or at least since the deluge; so that now it must be equal in height to the highest mountains in the world, and be visible at a great distance. Besides, the pieces broken off from the sides of such an immense mountain must be much thicker than any ice that is met with in the northern ocean; none of which is above two yards in height above the surface of the water, those immense pieces called *ice-mountains* being always formed on land.

Again, the system of nature is so formed, that all parts of the earth are exposed for the same length of time, or nearly so, throughout the year to the rays of the sun. But, by reason of the spheroidal figure of the terraqueous globe, the poles and polar regions enjoy the sun somewhat longer than others; and hence the Dutch who wintered in Nova Zembla in 1672 saw the sun a fortnight sooner than they ought to have done by astronomical calculations. By reason of this flatness about the poles, too, the sun not only shines for a greater space of time on these inhospitable regions, but with less obliquity in the summer-time, and hence the effect of his rays must be the greater. Now Mr Barrington considers it as an absurd supposition, that this glorious luminary should shine for six months on a cake of barren ice where there is neither animal nor vegetable. He says that the polar seas are assigned by nature as the habitation of the whales, the largest animals in the creation; but if the greatest part of the polar seas are for ever covered with an impenetrable cake of ice, these huge animals will be confined within very narrow bounds; for they cannot subsist without frequently coming to the top of the water to breathe.

15 Quantity of ice formed is not always in proportion to the degree of cold.

Lastly, the quantity of water frozen by different degrees of cold is by no means directly in proportion to the

(A) See *M. Bauche's Observations on the North or Ice Sea*, where he gives an account of various attempts made to reach the pole, from which he is convinced that the sea is there open, and that the thing is practicable. M. de Pages, in his *Travels*, Vol. III. informs us, that he wished to take a voyage to the north seas, for the purpose of bringing under one view the various obstacles from the ice, which have impeded the researches of navigators in those seas; and for this purpose he was prepared to continue his voyage to as high a latitude as possible, and that he might be able to say whether any land actually exists north from the coast of Greenland. He sailed without any encouragement from his court (France) on the 16th of April 1776 from the Texel, in a Dutch vessel bound to Spitsbergen. On the 16th of May she was a little way north of 81°, the highest latitude she reached.

"Being now (says the author) less than 180 leagues from the pole, the idea of so small a distance served effectually to awaken my curiosity. Had I been able to inspire my fellow-voyagers with sentiments similar to my own, the winds and currents which at this moment carried us fast towards the pole, a region hitherto deemed inaccessible to the eye of mortals, would have been saluted with acclamations of joy. This quarter, however, is not the most eligible for such an enterprize: here the sea lying in the vicinity of those banks of ice, so frequent a little farther to the west, is much too confined. Nevertheless, when I consider the very changeable nature of the shoals under whatever form, even in their most crowded and compact state; their constant changes and concussions which break and detach them from one another, and the various expedients that may be employed for freeing the ship from confinement, as well as for obviating impending danger—I am far from viewing a voyage to the pole as a chimerical idea."

Pole. the intenſity of the cold, but likewiſe to the duration of it. Thus, large bodies of water are never frozen in any temperature of ſhort duration, though ſhallow bodies often are. Our author obſerves, that as much of a given maſs of water was frozen in five hours of a temperature 12° below the freezing point, as was frozen in one hour of the temperature 50° below it; and that long duration of the temperature between 20 and 32 is, with regard to the congelation of water, equivalent to intenſity of cold ſuch as is marked 0 and below 0 in Fahrenheit, but of ſhort duration. See COLD and CONGELATION.

16 Mr Forſter's arguments againſt the poſſibility of reaching the pole.

On the other hand, Mr Forſter, in his Obſervations, takes the contrary ſide of the queſtion with no little vehemence. "I know (ſays he) that M. de Buffon, Lomonoſof, and Crantz, were of opinion, that the ice found in the ocean is formed near the lands only from the freſh water and ice carried down into the ſea by the many rivers in Siberia, Hudſon's Bay, &c.; and therefore, when we fell in with ſuch quantities of ice in December 1772, I expected we ſhould ſoon meet with the land from whence theſe ice maſſes had been detached. But being diſappointed in the diſcovery of this land, though we penetrated beyond the 67° twice, and once beyond 71°, ſouth latitude, and having beſides ſome other doubts concerning the exiſtence of the pretended ſouthern continent, I thought it neceſſary to inquire what reaſons chiefly induced the above authors to form the opinion that the ice floating in the ocean muſt be formed near land, or that an auſtral land is abſolutely requiſite for that purpoſe; and having looked for their arguments, I find they amount chiefly to this: 'That the ice floating in the ocean is all freſh: that ſalt water does not freeze at all; or if it does, it contains briny particles. They infer from thence, that the ice in the ocean cannot be formed in the ſea far from any land: there muſt therefore exiſt auſtral lands; becauſe, in order to form an idea of the original of the great ice-maſſes agreeably to what is obſerved in the northern hemiſphere, they find that the firſt point for fixing the high ice-iſlands is the land; and, ſecondly, that the great quantity of flat ice is brought down the rivers.' I have impartially and carefully conſidered and examined theſe arguments, and compared every circumſtance with what we ſaw in the high ſouthern latitude, and with other known facts; and will here inſert the reſult of all my inquiries on this ſubject.

"Firſt, they obſerve the ice floating in the ocean to yield, by melting, freſh water: which I believe to be true. However, hitherto it has by no means been generally allowed to be freſh: for Crantz ſays expreſsly, that 'the flat pieces (forming what they call the *ice-fields)* are ſalt, becauſe they were congealed from ſea-water.' The ice taken up by us for watering the ſhip was of all kinds, and neverthelefs we found it conſtantly freſh: Which proves, either that the principle of analogy cannot be applied indiſcriminately in both hemiſpheres; and that one thing may be true in the northern hemiſphere which is quite otherwiſe in the ſouthern, from reaſons not yet known or diſcovered by us; or we muſt think that Crantz and others are miſtaken, who ſuppoſe the ice floating in the ocean to be ſalt.

"The next remark is, That ſalt water does not freeze at all; or if it does, it contains briny particles. M. de Buffon tells us, 'that the ſea between Nova Zembla and Spitzbergen, under the 79° north latitude, does not freeze, as it is there conſiderably broad: and that it is not to be apprehended to find the ſea frozen not even under the pole itſelf; for indeed there is no example of having ever found a ſea wholly frozen over, and at a conſiderable diſtance from the ſhores; that the only inſtance of a ſea entirely frozen is that of the Black Sea, which is narrow and not very ſalt, and receives a great many rivers coming from northern regions, and bringing down ice: that this ſea therefore ſometimes freezes to ſuch a degree, that its whole ſurface is congealed to a conſiderable thickneſs; and, if the hiſtorians are to be credited, was frozen, in the reign of the emperor Conſtantine Copronymus, 30 ells thick, not including 20 ells of ſnow which was lying on the ice. This fact, continues M. de Buffon, ſeems to be exaggerated: but it is true, however, that it freezes almoſt every winter; whilſt the high ſeas which are 1000 leagues nearer towards the pole do not freeze; which can have no other cauſe than the difference in ſaltneſs, and the little quantity of ice carried out by rivers, if compared to the enormous quantity of ice which the rivers convey into the Black Sea.' M. de Buffon is not miſtaken when he mentions that the Black Sea frequently freezes. Strabo informs us, that the people near the Boſphorus Cimmerius paſs this ſea in carts from Panticapæum to Phanagorea; and that Neoptolemus, a general of Mithridates Eupator, won a battle with his cavalry on the ice on the very ſpot where he gained a naval victory in the ſummer. Marcellinus Comes relates, that under the conſulſhip of Vincentius and Fravita, in the year 401 after Chriſt, the whole ſurface of the Pontus was covered with ice, and that the ice in ſpring was carried through the Propontis, during 30 days, like mountains. Zonaras mentions the ſea between Conſtantinople and Scutari frozen to ſuch a degree in the reign of Conſtantine Copronymus, that even loaded carts paſſed over it. The prince Demetrius Cantemir obſerves, that in the year 1620-1 there happened ſo intenſe a froſt, that the people walked over the ice from Conſtantinople to Iſkodar. All theſe inſtances confirm M. de Buffon's aſſertion. But as this great natural hiſtorian ſays that the Black Sea is the only inſtance of a ſea being entirely frozen (B), I muſt beg leave to diſſent from him; for it is equally well atteſted that the Baltic is ſometimes entirely frozen, according to Caſpar Schutz's account. In the year 1426, the winter was ſo ſevere, that people travelled over the ice acroſs the Baltic from Dantzic to Lubeck; and the ſea was likewiſe paſſable from Denmark to Mecklenburgh: and in the year 1459 the whole Baltic was entirely frozen, ſo that perſons travelled, both on foot and on horſeback, over

(B) In the year 860 the Mediterranean was covered with ice, ſo that people travelled in carts and horſes acroſs the Ionian Sea to Venice; *(Hermannus Contractus ap. Piſtor. Script.* t. ii. p. 236.) And in 1234 the Mediterranean was again thus frozen, that the Venetian merchants travelled over the ice with their merchandiſe to what place they choſe; *Matth. Paris*, p. 78.

Pole.

over ice from Denmark to the Venedick Hanſ-towns, called *Lubeck*, *Wiſmar*, *Roſtock*, and *Stralſund*, which had never happened before; people likewiſe travelled acroſs the Baltic over ice from Reval in Eſtland to Denmark and to Sweden, and back again, without the leaſt danger (c). But, according to Sæmund Frode, even the great German Ocean between Denmark and Norway was frozen in the year 1048, ſo that the wolves frequently ran over the ice from one country to the other. The great northern ocean is likewiſe moſt certainly ſometimes frozen to a great diſtance from any land: for Muller relates, that in the year 1715 a Coſſack called *Markoff*, with ſome other perſons, was ſent by the Ruſſian government to explore the north ſea; but finding it next to impoſſible to make any progreſs during ſummer on account of the vaſt quantities of ice commonly filling this ocean, he at laſt determined to try the experiment during winter. He therefore took ſeveral ſledges drawn according to the cuſtom of the country by dogs, which commonly go about 80 or 100 verſts per day, 105 of which make a degree; and on March the 15th, old ſtyle, with this caravan of nine perſons, he left the ſhores of Siberia at the mouth of the river Yana, under the 71° of north latitude, and proceeded for ſeven days together northward, ſo that he had reached at leaſt the 77° or 78° north latitude, when he was ſtopped by the ice, which there began to appear in the ſhape of prodigious mountains. He climbed up to the top of ſome of theſe ice-mountains: but ſeeing from thence no land, nor any thing except ice as far as the eye could reach, and having beſides no more food for his dogs left, he thought it very neceſſary to return; which he with great difficulty performed, on April the 3d, as ſeveral of the dogs, which had periſhed for want, were employed to ſupport thoſe that remained alive. Theſe facts, I believe, will convince the unprejudiced reader, that there are other ſeas beſides the Black Sea which really do freeze in winter, and that the ice carried down the rivers could not at leaſt freeze the German Ocean between Norway and Denmark, becauſe the rivers there are ſo ſmall, and bear a very inconſiderable proportion to the immenſe ocean, which, according to experiments made by Mr Wilke, is very ſalt, though near the land, in the Swediſh harbour of Landſcrona.

"Now, if ſix or ſeven degrees of latitude, containing from 360 to 420 ſea-miles, are not to be reckoned a great diſtance from the land, I do not know in what manner to argue, becauſe no diſtance whatſoever will be reckoned far from any land. Nay, if the Coſſack Markoff, being mounted on one of the higheſt ice-mountains, may be allowed to ſee at leaſt to the diſtance of 20 leagues, the extent alluded to above muſt then be increaſed to 480 Engliſh ſea-miles; which certainly is very conſiderable, and makes it more than probable that the ocean is frozen in winter, in high northern latitudes, even as far as the pole. Beſides, it invalidates the argument which theſe gentlemen wiſh to infer from thence, *that the ocean does not freeze in high latitudes, eſpecially where there is a conſiderably broad ſea*; for we have ſhown inſtances to the contrary.

"But M. de Buffon ſpeaks of ice carried down the rivers into the northern ocean, and forming there theſe immenſe quantities of ice. 'And in caſe, ſays he, we would ſuppoſe, againſt all probability, that at the pole it could be ſo cold as to congeal the ſurface of the ſea, it would remain equally incomprehenſible how theſe enormous floating ice-maſſes could be formed, if they had not land for a point to fix on, and from whence they are ſevered by the heat of the ſun. The two ſhips which the India Company ſent in 1739 upon the diſcovery of the auſtral lands, found ice in 47° or 48° ſouth latitude, but at no great diſtance from land; which they diſcovered, without being able to approach it. This ice, therefore, muſt have come from the interior parts of the lands near the ſouth pole; and we muſt conjecture, that it follows the courſe of ſeveral large rivers, waſhing theſe unknown lands, in the ſame manner as the rivers Oby, the Yeniſea, and the other great rivers which fall into the northern ſea, carry the ice-maſſes, which ſtop up the ſtraits of Waigats for the greater part of the year, and render the Tartarian ſea inacceſſible upon this courſe.' Before we can allow the analogy between the rivers Oby, Yeniſea, and the reſt which fall into the northern ocean, and thoſe coming from the interior parts of the auſtral lands, let us compare the ſituation of both countries, ſuppoſing the auſtral lands really to exiſt. The Oby, Yeniſea, and the reſt of the Siberian rivers, falling down into the northern

(c) In 1296 the Baltic was frozen from Gothland to Sweden. (*Incerti auctoris Annales Denor. in Weſtphalii monument. Cimbr.* t. i. p. 1392.

In 1306 the Baltic was, during fourteen weeks, covered with ice between all the Daniſh and Swediſh iſlands. (*Ludwig. reliquiæ, MSS.* t. ix. p. 170.)

In 1323 there was a road for foot-paſſengers and horſemen over the ice on the Baltic during ſix weeks. (*id. ibid.*)

In 1349, people walking over the ice from Stralſund to Denmark. (*Incerti auct. cit. ap. Ludwig.* t. ix. p. 181.)

In 1408 the whole ſea between Gothland and Oeland, and likewiſe between Roſtock and Gezoer, was frozen. (*id. ibid.*)

In 1423 the ice bore riding from Pruſſia to Lubec. (*Crantzii Vandal.* l. x. c. 40.) The whole ſea was covered with ice from Mecklenburg to Denmark. (*Incert. auct. ap. Ludwig.* t. ix. p. 125.)

In 1461 (ſays *Nicol. Marſchallus in Annal. Herul. ap. Weſtphal.* t. i. p. 261.) Tanta erat hyems, ut concreto gelu oceano plauſtris millia paſſuum ſupra CCC merces ad ultimam Thylen (*Iceland*) et Orcades veherentur *e Germania* tota pene bruma.

In 1545 the ſea between Roſtock and Denmark, and likewiſe between Fionia and Sealand, was thus frozen, that the people travelled over the ice on foot, with ſledges to which horſes and oxen were put. (*Anonym. ap. Ludwig.* t. ix. p. 176.)

In 1294 the Cattegat or ſea between Norway and Denmark was frozen; that from Oxſlo in Norway, they could travel on it to Jutland. (*Strelow Chron. Juthiland*, p. 148.)

Pole.

northern ocean, have their ſources in 48° and 50° north latitude, where the climate is mild and capable of producing corn of all kinds. All the rivers of this great continent increaſing, theſe great rivers have likewiſe their ſources in mild and temperate climates, and the main direction of their courſe is from ſouth to north; and the coaſt of the northern ocean, not reckoning its ſinuoſities, runs in general weſt and eaſt. The ſmall rivers which are formed in high latitudes have, properly ſpeaking, no ſources, no ſprings, but carry off only the waters generated by the melting of ſnow in ſpring, and by the fall of rain in the ſhort ſummer, and are for the greateſt part dry in autumn. And the reaſon of this phenomenon is obvious, after conſidering the conſtitution of the earth in thoſe high northern climates. At Yakutſk, in about 62° north latitude, the ſoil is eternally frozen, even in the height of ſummer, at the depth of three feet from the ſurface. In the years 1685 and 1686, an attempt was made to dig a well; and a man, by great and indefatigable labour, continued during two ſummer-ſeaſons, and ſucceeded ſo far in this laborious taſk, that he at laſt reached the depth of 91 feet; but the whole earth at this depth was frozen, and he met with no water; which forced him to deſiſt from ſo fruitleſs an attempt. And it is eaſy to infer from hence how impoſſible it is that ſprings ſhould be formed in the womb of an eternally frozen ſoil.

17 Of the freezing of ſalt-water.

"The argument, therefore, is now reduced to this, *That ſalt water does not freeze at all; or, if it does, the ice contains briny particles.* But we have already produced numberleſs inſtances, that the ſea does freeze; nay, Crantz allows, *that the flat pieces of ice are ſalt, becauſe they were congealed from ſea-water.* We beg leave to add a few deciſive facts relative to the freezing of the ſea. Barentz obſerves in the year 1596, September the 16th, the ſea froze two fingers thick, and next night the ice was as thick again. This happened in the midſt of September; what effect then muſt the intenſe froſt of a night in January not produce? When Captain James wintered in Charleton's Iſle, the ſea froze in the middle of December 1631. It remains, therefore, only to examine, whether the ice formed in the ſea muſt neceſſarily contain briny particles. And here I find myſelf in a very diſagreeable dilemma; for during the intenſe froſt of the winter in 1776, two ſets of experiments were made on the freezing of ſea-water, and publiſhed, contradicting one another almoſt in every material point. The one by Mr Edward Nairne F. R. S. an ingenious and accurate obſerver; the other by Dr Higgins, who reads lectures on chemiſtry and natural philoſophy, and conſequently muſt be ſuppoſed to be well acquainted with the ſubject. I will therefore ſtill venture to conſider the queſtion as undecided by theſe experiments, and content myſelf with making a few obſervations on them: but previouſly I beg leave to make this general remark, that thoſe who are well acquainted with mechanics, chemiſtry, natural philoſophy, and the various arts which require a nice obſervation of minute circumſtances, need not be informed, that an experiment or machine ſucceeds often very well when made upon a ſmaller ſcale, but will not anſwer if undertaken at large; and, *vice verſa*, machines and experiments executed upon a ſmall ſcale will not produce the effect which they certainly have when made in a more enlarged manner. A few years ago an experiment made on the dyeing of ſcarlet, did not ſucceed when undertaken on a ſmall ſcale, whereas it produced the deſired effect when tried at a dyer's houſe with the large apparatus; and it evidently confirms the above aſſertion, which I think I have a right to apply to the freezing of ſalt-water. It is therefore probable, that the ice formed in the ocean at large, in a higher latitude, and in a more intenſe degree of cold, whereof we have no idea here, may become ſolid, and free from any briny particles, though a few experiments made by Dr Higgins, in his houſe, on the freezing of ſalt-water, produced only a looſe ſpongy ice filled with briny particles.

18 Reſult of Mr Nairne's experiments on this ſubject.

"The ice formed of ſea-water by Mr Nairne was very hard, $3\frac{1}{2}$ inches long, and 2 inches in diameter: it follows from thence, that the waſhing the outſide of this ice in freſh water, could not affect the inſide of a hard piece of ice. This ice when melted yielded freſh water, which was ſpecifically lighter than water which was a mixture of rain and ſnow-water, and next in lightneſs to diſtilled water. Had the ice thus obtained not been freſh, the reſiduum of the ſea-water, after this ice had been taken out, could not have been ſpecifically heavier than ſea-water, which, however, was the caſe in Mr Nairne's experiment. It ſeems, therefore, in my opinion, evident from hence, that ſalt-water does freeze, and has no other briny particles than what adhere to its outſide. All this perfectly agrees with the curious fact related by Mr Adanſon (D), who had brought to France two bottles of ſea-water, taken up in different parts of the ocean, in order to examine it, and to compare its ſaltneſs, when more at leiſure; but both the bottles containing the ſalt-water were burſt by being frozen, and the water produced from melting the ice proved perfectly freſh. This fact is ſo fairly ſtated, and ſo very natural, that I cannot conceive it is neceſſary to ſuppoſe, without the leaſt foundation for it, *that the bottles were changed, or that Mr Adanſon does not mention the circumſtance by which the ſea-water was thus altered upon its being diſſolved:* for as he expreſsly obſerves the bottles to have been burſt, it is obvious that the concentrated briny parts ran out, and were entirely drained from the ice, which was formed of the freſh water only.

"The ice formed by Dr Higgins from ſea-water, *conſiſted of thin laminæ, adhering to each other weakly.* Dr Higgins took out the frozen ice from the veſſels wherein he expoſed the ſea-water, and continued to do ſo till the remaining concentrated ſea-water began to form cryſtals of ſea-ſalt. Both theſe experiments, therefore, by no means prove what the Doctor intended to infer from thence; for it was wrong to take out ſuch ice, which only *conſiſted of thin laminæ, adhering to each other weakly.* Had he waited with patience, he would have obtained a hard ice as well as Mr Nairne, which, by a more perfect congelation, would have excluded the

(D) Second Supplement to the Probability of reaching the North Pole, p. 119.

the briny particles intercepted between the *thin laminæ, adhering to each other weakly*; and would have connected the laminæ, by others formed by fresh water. The Doctor found afterwards, it is true, thicker and somewhat more solid ice: but the sea-water had already been so much concentrated by repeated congelations, that it is no wonder the ice formed in it became at last brackish: it should seem, then, that no conclusive arguments can be drawn from these experiments.

"There are two other objections against the formation of the ice in the great ocean. The *first* is taken from the immense bulk and size of the ice masses formed in the ocean, which is *the deepest mass of water we know of*. But it has been experimentally proved, that in the midst of summer, in the latitudes of 55°, 55° 26′, and 64° south, at 100 fathoms depth, the thermometer stood at 34°, 34°½ and 32°; and that in all instances, the difference between the temperature at top and 100 fathoms depth never exceeded four degrees of Fahrenheit's thermometer, or that the temperature of the air did not differ five degrees from that of the ocean at 100 fathom deep. If we now add to this, that beyond the 71° south the temperature of the air and ocean must be still colder, and that the rigours of an antarctic winter are certainly more than sufficient to cool the ocean to 28°½, which is requisite for congealing the aqueous particles in it; if we moreover consider, that these severe frosts are continued during six or eight months of the year, we may easily conceive that there is time enough to congeal large and extensive masses of ice. But it is likewise certain, that there is more than one way by which those immense ice masses are formed. We suppose very justly, that the ocean does freeze, having produced so many instances of it; we allow likewise, that the ice thus formed in a calm, perhaps does not exceed three or four yards in thickness; a storm probably often breaks such an ice-field, which Crantz allows to be 200 leagues one way and 80 the other; the pressure of the broken fragments against one another frequently sets one upon the other piece, and they freeze in that manner together; several such double pieces, thrown by another pressure upon one another, form at last large masses of miles extent, and of 20, 40, 60, and more fathoms thickness, or of a great bulk or height. Martens, in his description of Spitzbergen, remarks, that the pieces of ice cause so great a noise by their shock, that the navigators in those regions can only with difficulty hear the words of those that speak; and as the ice-pieces are thrown one upon another, ice-mountains are formed by it. And I observed very frequently, in the years 1772 and 1773, when we were among the ice, masses which had the most evident marks of such a formation, being composed of strata of some feet in thickness. This is in some measure confirmed by the state in which the Cossack Markoff found the ice at the distance of 420 miles north from the Siberian coasts. The high masses were not found formed, as is suspected in the *Second supplement to the probability of reaching the north pole*, p. 143-145, near the land, under the high cliffs, but far out at sea; and when these ice mountains were climbed by Markoff, nothing but ice, and no vestiges of land, appeared as far as the eye could reach. The high climates near the poles are likewise subject to heavy falls of snow, of several yards in thickness, which grow more and more compact, and by thaws and rain are formed into solid ice, which increase the stupendous size of the floating ice mountains.

"The *second* objection against the freezing of the ocean into such ice as is found floating in it, is taken from the *opacity* of ice formed in salt water; because the largest masses are commonly transparent like crystal, with a fine blue tint, caused by the reflection of the sea. This argument is very specious, and might be deemed unanswerable by those who are not used to cold winters and their effects. But whosoever has spent several winters in countries which are subject to intense frosts, will find nothing extraordinary or difficult in this argument: for it is a well-known fact in cold countries, that the ice which covers their lakes and rivers is often opaque, especially when the frost sets in, accompanied by a fall of snow; for, in those instances, the ice looks, before it hardens, like a dough or paste, and when congealed it is opaque and white; however, in spring, a rain and the thaw, followed by frosty nights, change the opacity and colour of the ice, and make it quite transparent and colourless like a crystal: but, in case the thaw continues, and it ceases entirely to freeze, the same transparent ice becomes soft and porous, and turns again entirely opaque. This I believe may be applicable to the ice seen by us in the ocean. The field-ice was commonly opaque; some of the large masses, probably drenched by rain, and frozen again, were transparent and pellucid; but the small fragments of loose ice, formed by the decay of the large masses, and soaked by long-continued rains, we found to be porous, soft, and opaque.

"It is likewise urged as an argument against the formation of ice in the ocean, that it always requires land, in order to have a point upon which it may be fixed. First, I observe, that in Mr Nairne's experiments, the ice was generated on the surface, and was seen shooting crystals downwards: which evidently evinces, in my opinion, that ice is there formed or generated where the intensest cold is; as the air sooner cools the surface than the depth of the ocean, the ice shoots naturally downwards, and cools the ocean more and more, by which it is prepared for further congelation. I suppose, however, that this happens always during calms, which are not uncommon in high latitudes, as we experienced in the late expedition. Nor does land seem absolutely necessary in order to fix the ice; for this may be done with as much ease and propriety to the large ice mountains which remain undissolved floating in the ocean in high latitudes; or it may, perhaps, not be improper to suppose, that the whole polar region, from 80° and upwards, in the southern hemisphere, remains a solid ice for several years together, to which yearly a new circle of ice is added, and of which, however, part is broken off by the winds and the return of the mild season. Wherever the ice floats in large masses, and sometimes in compact bodies formed of an infinite number of small pieces, there it is by no means difficult to freeze the whole into one piece; for amongst the ice the wind has not a power of raising high and great waves. This circumstance was not entirely unknown to the ancients; and it is probable they acquired this information from the natives of

Pole. of ancient Gaul, and from the Britons and other northern nations, who sometimes undertook long voyages. The northern ocean was called by the ancients the *frozen*, the *dead*, the *lazy*, and *immoveable sea*: sometimes they gave it the name *mare cronium*, the concrete sea, and *morimarusa*, the dead sea. And, what is very remarkable, in all the northern cold countries the frost sometimes is so intense, that all the waters become suddenly coagulated into a kind of paste or dough, and thus at once congeal."

19 Observations on Mr Forster's reasoning.

On this reasoning of Mr Forster's, however, we must observe, that it cannot possibly invalidate any fact which Mr Barrington has advanced. The best concerted and most plausible theory in the world must yield to experience; for this is in fact what must judge all theories. Now, from what we have already related, it is demonstrated, that in the space between the mouths of the rivers Piasida and Chatanga more ice must be formed, and more intense colds generated, than in any other part of the world; consequently, for a considerable space both on the east and west side of that, the sea must be more full of ice than anywhere else. Now, between these two rivers there is the promontory of Taimura, which runs out to the latitude of 78°, or near it, and which of necessity must obstruct the dispersion of the ice; and that it actually does so is in some degree probable, because in one of the Russian voyages above-mentioned the eastern mouth of the Lena was quite free, when the western ones were entirely choaked up with ice. Now the mouth of the Yana lies several degrees to the eastward of the Lena: consequently, when the ice comes eastward from the Cape of Taimura, it must necessarily fill all that sea to the latitude of 78° and upwards; but the Cossack Markoff, if he proceeded directly north, could not be farther than the promontory of Taimura, and consequently still enveloped among the ice. Besides, we are certain, that the sea in 78° is not at all frozen into a solid cake in some places, since Lord Mulgrave, in 1773, reached 81°. Mr Forster's argument, therefore, either proves nothing, or it proves too much. If it proves, that about the middle of the eastern continent the cold is so intense that a sufficient quantity of ice is formed to obstruct the navigation for several hundred miles round, this proves nothing; because we knew before that this must be the case: But if it proves, that the sea must be unnavigable by reason of ice all round the globe at 78° N. L. this is too much; because we certainly know, that in 1773 Lord Mulgrave reached the latitude of 81°. However, though it should be allowed that the sea is quite clear all the way to the pole, it must be a very great uncertainty whether any ship could by that way reach the East Indies; because we know that it must sail down between the continents of Asia and America, through that strait whose mouth must often be blocked up with ice driving eastward along the continent of Asia.

The south pole is still more inaccessible than the north pole; for the ice is found in much lower southern than northern latitudes. Upon this subject M. Pages speaks thus: "Having in former voyages (says he) visited many parts of the terraqueous globe in different latitudes, I had opportunities of acquiring a considerable knowledge of climate in the torrid as well as in the temperate divisions of the earth. In a subsequent voyage I made it my business to be equally well informed respecting the reputed inhospitable genius of the South Seas; and upon my return from that expedition I entertained not the smallest doubt that there exists a peculiar and perpetual rigour in the southern hemisphere." (See his *Travels round the World*, v. iii. translated from the French, and printed at London, 1792, for Murray.) This superior degree of cold has by many been supposed to proceed from a greater quantity of land about the south than the north pole*; and the notion of a vast continent in these regions prevailed almost universally, insomuch that many have sought for it, but hitherto in vain. See the articles *Cook's Discoveries*, n° 38—49. and n° 68. and 69. *South-Sea*, and *Terra Australis*.

Pole ‖ Polemo.

* See America, n° 3—5, and Cook's Discoveries, n° 38, &c.

Magnetic Pole. See Magnet, Magnetism, § 4. p. 432. and p. 441. and Variation.

North Pole. See Pole.

Pole-Axe, a sort of hatchet nearly resembling a battle-axe, having an handle about 15 inches in length, and being furnished with a sharp point or claw, bending downwards from the back of its head; the blade whereof is formed like that of any other hatchet. It is principally employed in sea-fights to cut away and destroy the rigging of any adversary who endeavours to board.

Pole-axes are also said to have been successfully used on some occasions in boarding an enemy, whose sides were above those of the boarder. This is executed by detaching several gangs to enter at different parts of the ship's length, at which time the pole-axes are forcibly driven into her side, one above another, so as to form a sort of scaling-ladders.

Pole Cat. See Mustela.

Pole Star. See Astronomy, n° 3. 17. and 39.

POLEIN, in English antiquity, is a sort of shoe, sharp or picked at the point. This fashion took its rise in the time of king William Rufus; and the picks were so long, that they were tied up to the knees with silver or golden chains. They were forbidden by stat. an. 4 Edw. IV. cap. 7. *Tunc fluxus crinium, tunc luxus vestium, tunc usus calceorum cum arcuatis aculeis inventus est.* Malmesb. in Will. ii.

POLEMARCHUS was a magistrate at Athens, who had under his care all the strangers and sojourners in the city, over whom he had the same authority that the archon had over the citizens. It was his duty to offer a solemn sacrifice to Enyalus (said to be the same with Mars, though others will have it that he was only one of his attendants), and another to Diana, surnamed Αγροτερα, in honour of the famous patriot Harmodius. It was also his business to take care that the children of those that had lost their lives in the service of their country should be provided for out of the public treasury.

Potter's Grecian Antiquities.

POLEMICAL, in matters of literature, an appellation given to books of controversy, especially those in divinity.

POLEMO, who succeeded Xenocrates in the direction of the academy, was an Athenian of distinguished birth, and in the earlier part of his life a man of loose morals. The manner in which he was reclaimed from the pursuit of infamous pleasures, and brought under the discipline of philosophy, affords a memorable example of the power of eloquence employed in the cause of virtue. His history is thus related by Dr Enfield: "As he was, one morning about the rising of the sun, returning home from the revels of the

 night,

night, clad in a loose robe, crowned with garlands, ſtrongly perfumed, and intoxicated with wine, he paſſed by the ſchool of Xenocrates, and ſaw him ſurrounded with his diſciples. Unable to reſiſt ſo fortunate an opportunity of indulging his ſportive humour, he ruſhed without ceremony into the ſchool, and took his place among the philoſophers. The whole aſſembly was aſtoniſhed at this rude and indecent intruſion, and all but Xenocrates diſcovered ſigns of reſentment. Xenocrates, however, preſerved the perfect command of his countenance; and with great preſence of mind turned his diſcourſe from the ſubject on which he was treating to the topics of temperance and modeſty, which he recommended with ſuch ſtrength of argument, and energy of language, that Polemo was conſtrained to yield to the force of conviction. Inſtead of turning the philoſopher and his doctrine to ridicule, as he at firſt intended, he became ſenſible of the folly of his former conduct; was heartily aſhamed of the contemptible figure which he had made in ſo reſpectable an aſſembly; took his garland from his head; concealed his naked arm under his cloak; aſſumed a ſedate and thoughtful aſpect; and, in ſhort, reſolved from that hour to relinquiſh his licentious pleaſures, and devote himſelf to the purſuit of wiſdom. Thus was this young man, by the powerful energy of truth and eloquence, in an inſtant converted from an infamous libertine to a reſpectable philoſopher. In ſuch a ſudden change of character it is difficult to avoid paſſing from one extreme to another. Polemo, after his reformation, in order to brace up his mind to the tone of rigid virtue, conſtantly practiſed the ſevereſt auſterity and moſt hardy fortitude. From the thirtieth year of his age to his death he drank nothing but water. When he ſuffered violent pain, he ſhowed no external ſign of anguiſh. In order to preſerve his mind undiſturbed by paſſion, he habituated himſelf to ſpeak in an uniform tone of voice, without elevation or depreſſion. The auſterity of his manners was, however, tempered with urbanity and generoſity. He was fond of ſolitude, and paſſed much of his time in a garden near his ſchool. He died, at an advanced age, of a conſumption. Of his tenets little is ſaid by the ancients, becauſe he ſtrictly adhered to the doctrine of Plato."

POLEMONIUM, Greek Valerian, or *Jacob's Ladder:* A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 29th order, *Campanaceæ*. The corolla is quinquepartite; the ſtamina inſerted into ſcales, which cloſe the bottom of the corolla; the ſtigma is trifid: the capſule bilocular ſuperior. There are two ſpecies, of which the moſt remarkable is the cœruleum, with an empalement longer than the flower. It grows naturally in ſome places of England: however, its beauty has obtained it a place in the gardens. There are three varieties; one with a white, another with a blue, and another with a variegated flower; alſo a kind with variegated leaves. They are eaſily propagated by ſeeds; but that kind with variegated leaves is preſerved by parting its roots, becauſe the plants raiſed from ſeeds would be apt to degenerate and become plain.

POLEMOSCOPE, in optics, the ſame with Opera-glass. See Dioptrics, p. 37. col. 1. par. 3.

POLENBURG (Cornelius), an excellent painter of little landſcapes and figures, was born at Utrecht in 1586, and educated under Blomaert, whom he ſoon quitted to travel into Italy; and ſtudied for a long time in Rome and Florence, where he formed a ſtyle entirely new, which, though preferable to the Flemiſh, is unlike any Italian, except in his having adorned his landſcapes with ruins. There is a varniſhed ſmoothneſs and finiſhing in his pictures, that render them always pleaſing, though ſimple and too nearly reſembling one another. The Roman cardinals were charmed with the neatneſs of his works, as was alſo the great duke; but could not retain him. He returned to Utrecht, and pleaſed Rubens, who had ſeveral of his performances. King Charles I. invited him to London, where he generally painted the figures in Steenwyck's perſpectives: but the king could not prevail on him to fix here; for after ſtaying only four years, and being handſomely rewarded by his majeſty for ſeveral pieces which he performed for him, he returned to Utrecht, and died there at the age of 74. His works are very ſcarce and valuable.

POLERON, one of the Banda or nutmeg iſlands in the Eaſt Indies. This was one of thoſe ſpice iſlands which put themſelves under the protection of the Engliſh, and voluntarily acknowledged James I. king of England for their ſovereign; for which reaſon the natives of this and the reſt of the iſlands were murdered or driven thence by the Dutch, together with the Engliſh.

POLESIA, a province of Poland, bounded by Polachio and Proper Lithuania on the north, and by Volhinia on the ſouth. It is one of the palatinates of Lithuania, and is commonly called *Breſcia*, and its capital is of this name. It is full of foreſts and lakes.

POLESINO-de-Rovigo, a province of Italy, in the republic of Venice, lying to the north of the river Po; and bounded on that ſide by the Paduan, on the ſouth by the Ferrareſe, on the eaſt by Degado, and on the weſt by the Veroneſe. It is 45 miles in length, and 17 in breadth, and is a fertile country. Rovigo is the capital.

POLETÆ were ten magiſtrates of Athens, who, with three that had the management of money allowed for public ſhows, were empowered to let out the tribute-money and other public revenues, and to ſell confiſcated eſtates; all which bargains were ratified by their preſident, or in his name. They were by their office alſo bound to convict ſuch as had not paid the tribute called Μετοικιον, and ſell them in the market by auction. The market where theſe wretches were ſold was called πωλητηριον του μετοικιου.

POLIANTHES, the Tuberose: A genus of the monogynia order, belonging to the hexandria claſs of plants; and in the natural method ranking under the 10th order, *Coronariæ*. The corolla is funnel-ſhaped, incurvated, and equal; the filaments are inſerted into the throat of the corolla; in the bottom of which the germen is ſituated. There is but one ſpecies, conſiſting of ſome varieties; all of which being exotics of tender quality, require aid of artificial heat, under ſhelter of frames and glaſſes, &c. to bring them to flower in perfection in this country. The polianthes, or tuberoſe, hath an oblong, bulb-like, tuberous, white root; crowned with a few long very narrow leaves; amidſt them an upright, ſtraight, firm ſtem, three or four feet high, terminated by a long ſpike of large white flowers arranged alternately. The varieties are the common tu-

Polianthes. berose, with single flowers,—double-flowered,—dwarf-ſtalked,—variegated-leaved. They all flower here in June, July, and Auguſt: the flowers are funnel or bell ſhaped; garniſh the upper part of the ſtem in a long ſpike, conſiſting of from 10 to 20 or more ſeparate in alternate arrangements, the lower flowers opening firſt, which are ſucceeded by thoſe above, in regular order, making in the whole a moſt beautiful appearance, highly enriched with a moſt fragrant odour. The common ſingle-flowered tuberoſe is the ſort the moſt commonly cultivated, as it generally blows the moſt freely, and poſſeſſes the fineſt fragrance. The double-flowered kind alſo highly merits culture, as when it blows fair it makes a ſingularly fine appearance. The dwarf and the variegated kinds are inferior to the other two, but may be cultivated for variety.

All the varieties being exotics from warm countries, although they are made to flower in great perfection in our gardens by aſſiſtance of hot-beds, they will not proſper in the open ground, and do not increaſe freely in England; ſo that a ſupply of the roots is imported hither annually from Genoa, and other parts of Italy, by moſt of the eminent nurſery and ſeedſmen, and the Italian warehouſe-keepers; generally arriving in February or March, time enough for the enſuing ſummer's bloom; and are ſold commonly at the rate of twelve or fifteen ſhillings per hundred, being careful always to procure as large roots as poſſible, for on this depends the ſucceſs of having a complete blow. They, requiring artificial heat to blow them in this country, are planted in pots, and plunged in a hot-bed, under a deep frame furniſhed with glaſs lights; or placed in a hot-houſe, where they may be blowed to great perfection with little trouble. The principal ſeaſon for planting them is March and April: obſerving, however, that in order to continue a long ſucceſſion of the bloom, it is proper to make two or three different plantings, at about a month interval; one in March, another in April, and a third the beginning of May, whereby the blow may be continued from June until September; obſerving, as above-mentioned, they may be flowered either by aid of a common dung or bark hot-bed, or in a hot-houſe.

With reſpect to the propagation of theſe plants, it is principally by offsets of the roots. The blowing roots that are brought annually from abroad for ſale are often furniſhed with offsets, which ought to be ſeparated previous to planting. Thoſe alſo that are planted here in our gardens frequently furniſh offsets fit for ſeparation in autumn when the leaves decay: they muſt then be preſerved in ſand all winter in a dry ſheltered place; and in the beginning of March, plant them either in a bed of light dry earth in the full ground; or, to forward them as much as poſſible, allow them a moderate hot-bed; and in either method indulge them with a ſhelter in cold weather, either of a frame and lights, or arched with hoops and occaſionally matted; but let them enjoy the full air in all mild weather, giving alſo plenty of water in dry weather during the ſeaſon of their growth in ſpring and ſummer. Thus let them grow till their leaves again decay in autumn: then take them up, clean them from earth, and lay them in ſand till ſpring; at which time ſuch roots as are large enough to blow may be planted and managed as already directed, and the ſmaller roots planted again in a nurſery-bed, to have another year's growth; afterwards plant them for flowering. The Egyptians put the flowers of tuberoſe into ſweet oil; and by this means give it a moſt excellent flavour, ſcarce inferior to oil of jaſmine.

Polĩ
Poli

POLICANDRO, a ſmall iſland in the Archipelago, ſeated between Milo and Morgo. It has no harbour, but has a town about three miles from the ſhore near a huge rock. It is a ragged ſtony iſland, but yields as much corn as is ſufficient for the inhabitants, who conſiſt of about 120 Greek families, all Chriſtians. The only commodity is cotton; of which they make napkins, a dozen of which are ſold for a crown. E. Long. 35. 25. N. Lat. 36. 36.

POLICASTRO, an epiſcopal town of Italy, in the kingdom of Naples, and in the Hither Principato; but now almoſt in ruins, for which reaſon the biſhop reſides in another town. E. Long. 15. 46. N. Lat. 40. 26.

POLICY, or Polity, in matters of government. See Polity.

Policy of Inſurance, or *Aſſurance*, of ſhips, is a contract or convention, whereby a perſon takes upon himſelf the riſks of a ſea-voyage; obliging himſelf to make good the loſſes and damages that may befal the veſſel, its equipage, tackle, victualling, lading, &c. either from tempeſts, ſhipwrecks, pirates, fire, war, repriſals, in part or in whole; in conſideration of a certain ſum of ſeven, eight, or ten *per cent.* more or leſs according to the riſk run; which ſum is paid down to the aſſurer by the aſſuree upon his ſigning the policy. See Insurance.

POLIDORO da Caravaggio, an eminent painter, born at Caravaggio in the Milaneſe in 1492. He went young to Rome, where he worked as a labourer in preparing ſtucco for the painters; and was ſo animated by ſeeing them at work in the Vatican, that he ſolicited ſome of them to teach him the rules of deſigning. He attached himſelf particularly to Maturino, a young Florentine; and a ſimilarity in talents and taſte producing a diſintereſted affection, they aſſociated like brothers, laboured together, and lived on one common purſe, until the death of Maturino. He underſtood and practiſed the chiaro-ſcuro in a degree ſuperior to any in the Roman ſchool; and finiſhed an incredible number of pictures both in freſco and in oil, few of the public buildings at Rome being without ſome of his paintings. Being obliged to fly from Rome when it was ſtormed and pillaged, he retired to Meſſina, where he obtained a large ſum of money with great reputation, by painting the triumphal arches for the reception of Charles V. after his victory at Tunis: and when he was preparing to return to Rome, he was murdered, for the ſake of his riches, by his Sicilian valet with other aſſaſſins, in the year 1543.

POLIFOLIA. See Andromeda.

POLIGNAC (Melchier de), an excellent French genius and a cardinal, was born of an ancient and noble family at Puy, the capital of Velay, in 1662. He was ſent by Louis XIV. ambaſſador extraordinary to Poland, where, on the death of Sobieſki, he formed a project of procuring the election of the prince of Conti. But failing, he returned home under ſome diſgrace; but when reſtored to favour, he was ſent to Rome as auditor of the Rota. He was plenipotentiary during the congreſs at Utrecht, at which time Clement I. created him a cardinal; and upon the acceſſion of Louis XV. he was appointed to reſide at Rome as miniſter of France.

France. He remained there till the year 1732, and died in the year 1741. He left behind him a MS. poem entitled *Anti-Lucretius, ſeu De Deo et Natura;* the plan of which he is ſaid to have formed in Holland in a converſation with Mr Bayle. This celebrated poem was firſt publiſhed in the year 1749, and has ſince been ſeveral times printed in other countries beſides France. He had been received into the French Academy in 1704, into the Academy of Sciences in 1715, into that of the Belles Lettres in 1717: and he would have been an ornament to any ſociety, having all the accompliſhments of a man of parts and learning.

POLISHER, or Burnisher, among mechanics, an inſtrument for poliſhing and burniſhing things proper to take a poliſh. The gilders uſe an iron-poliſher to prepare their metals before gilding, and the bloodſtone to give them the bright poliſh after gilding.

The poliſhers, among cutlers, are a kind of wooden wheels made of walnut-tree, about an inch thick, and of a diameter at pleaſure, which are turned round by a great wheel; upon theſe they ſmooth and poliſh their work with emery and putty.

The poliſhers for glaſs conſiſt of two pieces of wood; the one flat, covered with old hat; the other long and half-round, faſtened on the former, whoſe edge it exceeds on both ſides by ſome inches, which ſerves the workmen to take hold of, and to work backwards and forwards by.

The poliſhers uſed by ſpectacle-makers are pieces of wood a foot long, ſeven or eight inches broad, and an inch and a half thick, covered with old beaver hat, whereon they poliſh the ſhell and horn frames their ſpectacle-glaſſes are to be ſet in.

POLISHING, in general, the operation of giving a gloſs or luſtre to certain ſubſtances, as metals, glaſs, marble, &c.

The operation of poliſhing optic-glaſſes, after being properly ground, is one of the moſt difficult points of the whole proceſs. See Telescope.

POLITENESS means elegance of manners or good breeding: Lord Cheſterfield calls it the art of pleaſing. It has alſo been called an artificial good nature; and indeed good nature is the foundation of true politeneſs; without which art will make but a very indifferent figure, and will generally defeat its own ends. "Where compliance and aſſent, caution and candour, ſays an elegant eſſayiſt *, ariſe from a natural tenderneſs of diſpoſition and ſoftneſs of nature, as they ſometimes do, they are almoſt amiable and certainly excuſable; but as the effects of artifice, they muſt be deſpiſed. The perſons who poſſeſs them are, indeed, often themſelves dupes of their own deceit, when they imagine others are deluded by it. For exceſſive art always betrays itſelf; and many, who do not openly take notice of the deceiver, from motives of delicacy and tenderneſs for his character, ſecretly deride and warmly reſent his ineffectual ſubtilty."

"True politeneſs (ſays another author †) is that continual attention which humanity inſpires us with, both to pleaſe others, and to avoid giving them offence. The ſurly plain-dealer exclaims loudly againſt this virtue, and prefers his own ſhocking bluntneſs and Gothic freedom. The courtier and fawning flatterer, on the contrary, ſubſtitute in its place inſipid compliments, cringings, and a jargon of unmeaning ſentences. The one blames politeneſs, becauſe he takes it for a vice; and the other is the occaſion of this, becauſe that which he practiſes is really ſo."

Both theſe characters act from motives equally abſurd, though not equally criminal. The conduct of the artful flatterer is guided by ſelf-love, while that of the plain-dealer is the effect of ignorance; for nothing is more certain, than that the deſire of pleaſing is founded on the mutual wants and the mutual wiſhes of mankind; on the pleaſure which we wiſh to derive from ſociety, and the character which we wiſh to acquire. Men having diſcovered that it was neceſſary and agreeable to unite for their common intereſts, they have made laws to repreſs the wicked, they have ſettled the duties of ſocial life, and connected the idea of reſpectability with the practice of thoſe duties; and after having preſcribed the regulations neceſſary to their common ſafety, they have endeavoured to render their commerce with one another agreeable, by eſtabliſhing the rules of politeneſs and good breeding. Indeed, as an elegant author already quoted remarks, the philoſopher who, in the auſterity of his virtue, ſhould condemn the art of pleaſing as unworthy cultivation, would deſerve little attention from mankind, and might be diſmiſſed to his ſolitary tub, like his brother Diogenes. It is the dictate of humanity, that we ſhould endeavour to render ourſelves agreeable to thoſe in whoſe company we are deſtined to travel in the journey of life. It is our intereſt, it is the ſource of perpetual ſatisfaction; it is one of our moſt important duties as men, and particularly required in the profeſſor of Chriſtianity."

It is needleſs to particularize the motives which have induced men to practiſe the agreeable virtues; for, from whatever ſource the deſire of pleaſing proceeds, it has always increaſed in proportion to the general civilization of mankind. In a rude ſtate of ſociety, pleaſure is limited in its ſources and in its operation. When the wants of mankind, and the means of attaining them, are few, perſonal application is neceſſary to gratify them, and it is generally ſufficient; by which means an individual becomes more independent than can poſſibly be the caſe in civilized life, and of courſe leſs diſpoſed to give or receive aſſiſtance. Confined to the ſolitary wiſh of furniſhing means for his own happineſs, he is little intent on the pleaſures of converſation and ſociety. His deſire of communication is equal to the extent of his knowledge. But as ſoon as the natural wants of life are filled up, we find unoccupied time, and we labour hard to make it paſs in an agreeable manner. It is then we perceive the advantage of poſſeſſing a rational nature, and the delights of mutual intercourſe. When we conſider ſociety in that ſtate of perfection which enables a great part of the members of it to purſue at leiſure the pleaſures of converſation, we ſhould expect, both from the eaſe of acquitting ourſelves to the ſatisfaction of our aſſociates, and from the advantages ariſing from this conduct, that the art of pleaſing might be reduced to a few plain and ſimple rules, and that theſe might be derived from a ſlight attention to general manners.

The art of pleaſing, in our intercourſe with mankind, is indeed ſo ſimple, that it requires nothing more than the conſtant deſire to pleaſe in all our words and actions; and the practice of it can neither wound a man's ſelf-love, nor be prejudicial to his intereſt in any poſſible ſituation.

But

Politeneſs.

But though this be certain, it is doubtleſs leſs attended to than in reaſon it ought to be. Each particular man is ſo zealous to promote his own ends or his own pleaſure, as to forget that his neighbour has claims equal to his own; that every man that enters into company gives up for the time a great many of his peculiar rights; and that he then forms part of an aſſociation, met together not for the particular gratification of any one, but for the purpoſe of general ſatisfaction. See BREEDING, CONVERSATION, and *Good MANNERS*.

The qualities eſſential in the art of pleaſing, are *virtue*, *knowledge*, and *manners*. All the virtues which form a good and reſpectable character in a moral ſenſe are eſſential to the art of pleaſing. This muſt be an eſtabliſhed principle, becauſe it depends on the wants and mutual relations of ſociety. In all affairs of common buſineſs, we delight in tranſacting with men in whom we can place confidence, and in whom we find integrity; but truth is ſo naturally pleaſing, and the common affairs of life are ſo interwoven with ſocial intercourſe, that we derive abundantly more ſatisfaction from an honeſt character than from ſpecious manners. "Should you be ſuſpected (ſays Cheſterfield) of injuſtice, malignity, perfidy, lying, &c. all the parts and knowledge of the world will never procure you eſteem, friendſhip, and reſpect."

The firſt of virtues in our commerce with the world, and the chief in giving pleaſure to thoſe with whom we aſſociate, is inviolable ſincerity of heart. We can never be too punctual in the moſt ſcrupulous tenderneſs to our moral character in this reſpect, nor too nicely affected in preſerving our integrity.

The peculiar modes, even of the faſhionable world, which are founded in diſſimulation, and which on this account have induced ſeveral to recommend the practice, would not prevent a man of the higheſt integrity from being acceptable in the very beſt company. Acknowledged ſincerity gives the ſame ornament to character that modeſty does to manners. It would abundantly atone for the want of ridiculous ceremony, or falſe and unmeaning profeſſions; and it would in no reſpect diminiſh the luſtre of a noble air, or the perfection of an elegant addreſs.

If integrity be the foundation of that character which is moſt generally acceptable, or which, in other words, poſſeſſes the power of pleaſing in the higheſt degree, humanity and modeſty are its higheſt ornaments.

The whole art of pleaſing, as far as the virtues are concerned, may be derived from the one or other of theſe ſources. Humanity comprehends the diſplay of every thing amiable to others; modeſty removes or ſuppreſſes every thing offenſive in ourſelves.

This modeſty, however, is not inconſiſtent with firmneſs and dignity of character: it ariſes rather from the knowledge of our imperfection compared with a certain ſtandard, than from conſcious ignorance of what we ought to know. We muſt therefore diſtinguiſh between this modeſty and what the French call *mauvaiſe honte*. The one is the unaffected and unaſſuming principle which leads us to give preference to the merit of others, the other is the aukward ſtruggling of nature over her own infirmities. The firſt gives an additional luſtre to every good quality; while ſome people, from feeling the pain and inconveniency of the *mauvaiſe honte*, have ruſhed into the other extreme, and turned impudent, as cowards ſometimes grow deſperate from exceſs of danger. The medium between theſe two extremes marks out the well-bred man; he feels himſelf firm and eaſy in all companies, is modeſt without being baſhful, and ſteady without being impudent.

A man poſſeſſing the amiable virtues is ſtill farther prepared to pleaſe, by having in his own mind a perpetual fund of ſatisfaction and entertainment. He is put to no trouble in concealing thoughts which it would be diſgraceful to avow, and he is not anxious to diſplay virtues which his daily converſation and his conſtant looks render viſible.

The next ingredient in the art of pleaſing, is to poſſeſs a correct and enlightened underſtanding, and a fund of rational knowledge. With virtue and modeſty we muſt be able to entertain and inſtruct thoſe with whom we aſſociate.

The faculty of communicating ideas is peculiar to man, and the pleaſure which he derives from the interchange alone is one of the moſt important of his bleſſings. Mankind are formed with numberleſs wants, and with a mutual power of aſſiſting each other. It is a beautiful and happy part of the ſame perfect plan, that they are likewiſe formed to delight in each other's company, and in the mutual interchange of their thoughts. The different ſpecies of communication, in a highly poliſhed age, are as numerous as the different ranks, employments, and occupations of men; and indeed the knowledge which men wiſh to communicate, takes its tinge from their peculiar profeſſion or occupation.

Thus commercial men delight to talk of their trade, and of the nature of public buſineſs; men of pleaſure, who wiſh merely to vary or quicken their amuſements, are in converſation light, trifling, and inſincere; and the literati delight to dwell on new books, learned men, and important diſcoveries in ſcience or in arts. But as the different claſſes of men will frequently meet together, all parties muſt ſo contrive matters, as to combine the uſeful and agreeable together, ſo as to give the greateſt delight at the time, and the greateſt pleaſure on reflection. An attention to theſe principles would make the man of pleaſure and the man of learning meet together on equal terms, and derive mutual advantage from their different qualifications. With due attention to ſuch ideas, we proceed to mention the kinds of knowledge which are moſt fitted for converſation. Thoſe who wiſh to pleaſe ſhould particularly endeavour to be informed in thoſe points which moſt generally occur. An accurate or extenſive knowledge on learned ſubjects is by no means ſufficient: we muſt alſo have an accurate and extenſive knowledge of the common occurrences of life.

It is the knowledge of mankind, of governments, of hiſtory, of public characters, and of the ſprings which put the great and the little actions of the world in motion, which give real pleaſure and rational inſtruction. The knowledge which we communicate muſt in ſome ſhape be intereſting to thoſe to whom we communicate it; of that nature, that the deſire of receiving it may overbalance every kind of diſguſt, excited too often on the ſcore of envy and ſelf-love, againſt thoſe who happen to poſſeſs ſuperior endowments, and at the ſame time of that importance, as to elevate the thoughts ſomewhat above the actions and the faults of the narrow circle formed in our own immediate neighbourhood.

bourhood. On this account it is recommended by an author who fully knew mankind, as a maxim of great importance in the art of pleafing, to be acquainted with the private character of thofe men who, from their ftation or their actions, are making a figure in the world. We naturally wifh to fee fuch men in their retired and undifguifed moments; and he who can gratify us is highly acceptable. Hiftory of all kinds, fitly introduced, and occafionally embellifhed with pleafing anecdotes, is a chief part of our entertainment in the intercourfe of life. This is receiving inftruction, without exciting much envy; it depends on memory, and memory is one of thofe talents the poffeffion of which we leaft grudge to our neighbour. Our knowledge of hiftory, at the fame time, muft not appear in long and tedious details; but in apt and well-chofen allufions, calculated to illuftrate the particular fubject of converfation. But the knowledge moft neceffary is that of the human heart. This is acquired by conftant obfervation on the manners and maxims of the world, connected with that which paffes in our own minds. This leads us from the common details of conduct, from flander and defamation, to the fources and principles of action, and enables us to enter into what may be called the philofophy of converfation. We may fee both the practicability of this kind of difcourfe, and the nature of it, in the following lines of Horace:

Sermo oritur, non de villis domibufve alienis;
Nec male necne Lepos faltet: fed quod magis ad nos
Pertinet, & nefcire malum eft, agitamus: utrumne
Divitiis homines, an fint virtute beati?
Quidve ad amicitias, ufus rectumne, trahat nos?
Et quæ fit natura boni, fummumque quid ejus? &c.

By this means conftant materials are fupplied for free, eafy, and fpirited communication. The reftraints which are impofed on mankind, either from what their own character may fuffer, or from the apprehenfion of giving offence to others, are entirely taken off, and they have a fufficient quantity of current coin for all the common purpofes of life.

In addition to virtue and knowledge, which are the chief ingredients in the art of pleafing, we have to confider graceful and eafy manners. Lord Chefterfield indeed confiders thefe as the moft effential and important part; as if the diamond received its whole value from the polifh. But though he is unqueftionably miftaken, there is yet a certain fweetnefs of manners which is particularly engaging in our commerce with the world. It is that which conftitutes the character which the French, under the appellation of *l'aimable*, fo much talk of, and fo juftly value. This is not fo eafily defcribed as felt. It is the compound refult of different things; as complaifance, a flexibility, but not a fervility of manners, an air of foftnefs in the countenance, gefture, and expreffion, equally whether you concur or differ with the perfon you converfe with. This is particularly to be ftudied when we are obliged to refufe a favour afked of us, or to fay what in itfelf cannot be very agreeable to the perfon to whom we fay it. It is then the neceffary gilding of a difagreeable pill. But this, which may be called the *fuaviter in modo*, would degenerate and fink into a mean and timid complaifance and paffivenefs, if not fupported by firmnefs and dignity of character. Hence the Latin fentence, *fuaviter in modo*, *fortiter in re*, becomes a ufeful and important maxim in life.

Genuine eafy manners refult from a conftant attention to the relations of perfons, things, time, and places. Were we to converfe with one greatly our fuperior, we are to be as eafy and unembarraffed as with our equals; but yet every look, word, and action, fhould imply, without any kind of fervile flattery, the greateft refpect. In mixed companies, with our equals, greater eafe and liberty are allowed; but they too have their proper limits. There is a focial refpect neceffary. Our words, geftures, and attitudes, have a greater degree of latitude, though not an unbounded one. That eafinefs of carriage and behaviour which is exceedingly engaging, widely differs from negligence and inattention, and by no means implies that one may do whatever he pleafes; it only means, that one is not to be ftiff, formal, and embarraffed, difconcerted and afhamed; but it requires great attention to, and a fcrupulous obfervation of, what the French call *les bienfeances*; a word which implies "decorum, good-breeding, and propriety." Whatever we ought to do, is to be done with eafe and unconcern; whatever is improper, muft not be done at all. In mixed companies, alfo, different ages and fexes are to be differently addreffed. Although we are to be equally eafy with all, old age particularly requires to be treated with a degree of deference and regard. It is a good general rule, to accuftom ourfelves to have a kind feeling to every thing connected with man; and when this is the cafe, we fhall feldom err in the application. Another important point in the *bienfeances* is, not to run our own prefent humour and difpofition indifcriminately againft every body, but to obferve and adopt theirs. And if we cannot command one prefent humour and difpofition, it is neceffary to fingle out thofe to converfe with who happen to be in the humour the neareft to our own. Peremptorinefs and decifion, efpecially in young people, is contrary to the *bienfeances*: they fhould feldom feem to diffent, and always ufe fome foftening mitigating expreffion.

There is a *bienfeance* alfo with regard to people of the loweft degree; a gentleman obferves it with his footman, and even indeed with the beggar in the ftreet. He confiders them as objects of compaffion, not of infult; he fpeaks to neither in a harfh tone, but corrects the one coolly, and refufes the other with humanity.

The following obfervations perhaps contain the fum of the art of pleafing:

1. A fixed and habitual refolution of endeavouring to pleafe, is a circumftance which will feldom fail of effect, and its effect will every day become more vifible as this habit increafes in ftrength.

2. This refolution muft be regulated by a very confiderable degree of good fenfe.

3. It is a maxim of almoft general application, that what pleafes us in another will alfo pleafe others in us.

4. A conftant and habitual attention to the different difpofitions of mankind, to their ruling paffions, and to their peculiar or occafional humours, is abfolutely neceffary.

5. A man who would pleafe, muft poffefs a firm, equal, and fteady temper. And,

6. An eafy and graceful manner, as diftant from bafhfulnefs on the one hand as from impudence on the other.

other. " He who thinks himſelf ſure of pleaſing (ſays Lord Cheſterfield), and he who deſpairs of it, are equally ſure to fail." And he is undoubtedly in the right. The one, by his aſſuming vanity, is inattentive to the means of pleaſing; and the other, from fear, is rendered incapable of employing them.

A variety of excellent rules for acquiring politeneſs, with ſtrictures on particular kinds of impoliteneſs, may be found in the *Spectator*, *Rambler*, *Idler*, *Lounger*, *Mirror*, and other periodical works of that kind; in *Knox's Eſſays*, and among *Swift's Works*; ſee *Good* MANNERS. *Cheſterfield's Art of Pleaſing*, and his *Letters*, are alſo worthy of peruſal, provided the reader be on his guard againſt the inſincerity and other vices which thoſe books are calculated to infuſe, and provided he always bears in mind what we have endeavoured to ſhow in this article, that true politeneſs does not conſiſt in ſpecious manners and a diſſimulating addreſs, but that it muſt always be founded on real worth and intrinſic virtue.

POLITIAN (Angelo), was born at Monte Pulciano in Tuſcany in 1454. He learned the Greek tongue, of which he became a complete maſter, under Andronicus of Theſſalonica. He is ſaid to have written verſes both in Greek and Latin when he was not more than 12 years of age. He ſtudied alſo the Platonic philoſophy under Marſilius Ficinus, and that of Ariſtotle under Argyropylus. He was one of the moſt learned and polite writers of his time. The firſt work which gained him a reputation was a poem on the tournament of Julian de Medicis. The account he wrote ſome time after of the conſpiracy of the Pazzi's was very much eſteemed. He wrote many other pieces which have merited approbation; and had he lived longer, he would have enriched the republic of letters with many excellent works; but he died at the age of 40 years. His morals anſwered the homelineſs of his face rather than the beauty of his genius; for Paul Jovius informs us, that " he was a man of aukward and perverſe manners, of a countenance by no means open and liberal, a noſe remarkably large, and ſquinting eyes. He was crafty, ſatirical, and full of inward malice: for his conſtant way was, to ſneer and ridicule the productions of other men, and never to allow any criticiſm, however juſt, upon his own."

He was, nevertheleſs, as all acknowledge, a man of moſt conſummate erudition; and not only ſo, but a very polite and elegant writer. Eraſmus, in his *Ciceronianus*, calls him a rare miracle of nature, on account of his excelling in every kind of writing: his words are remarkable: " *Fateor Angelum prorſus angelica fuiſſe mente, rarum naturæ miraculum, ad quodcunque ſcripti genus applicaret animum.*" Some of his poems were ſo much admired, that ſeveral learned men have made it their buſineſs to comment on them. It has been often reported that he ſpoke of the Bible with great contempt; and that, having read it but once, he complained he had never ſpent his time ſo ill. But this is not probable, for it muſt be remembered that he was a prieſt and canon of Florence; and we learn from one of his Epiſtles that he preached a whole Lent. It does not indeed follow hence, that he did not think contemptuouſly of the Bible, becauſe many of his church, eſpecially among the better ſort, have not been very good believers, and he might be one of them: but it is not likely he would ſpeak out ſo freely. " I could (as Bayle ſays) much more eaſily believe the judgment he is ſaid to have made on the Pſalms of David and the Odes of Pindar: he did not deny that there are many good and fine things in the Pſalms; but he pretended that the ſame things appear in Pindar with more brightneſs and ſweetneſs." The two Scaligers have ſpoken highly of Politian: the elder has preferred a conſolatory elegy of his to that which Ovid ſent to Livia upon the death of Druſus, and ſays, he had rather have been the author of it: the younger calls him an excellent poet, but thinks the ſtyle of his epiſtles too elated and declamatory.

His works have been printed at various times, and in various places: his epiſtles have probably been moſt read, becauſe theſe are things which the generality of people are beſt pleaſed with.

POLITICAL, from πολις " a city," ſignifies any thing that relates to policy or civil government.

POLITICAL *Arithmetic*, is the art of reaſoning by figures upon matters relating to government, ſuch as the revenues, number of people, extent and value of land, taxes, trade, &c. in any nation.

Theſe calculations are generally made with a view to aſcertain the comparative ſtrength, proſperity, &c. of any two or more nations. With this view, Sir William Petty, in his *Political Arithmetic*, p. 74, &c. computes the land of Holland and Zealand to be about 1,000,000 acres, and that of France to be 8,000,000; and yet the former is one-third part as rich and ſtrong as the latter. The ſhipping of Europe he computes to be about 2,000,000, of which Britain has 500,000; Holland 900,000; France 100,000; Hamburgh, Denmark, Sweden, and Dantzic 250,000; and Spain, Portugal, Italy, &c. the reſt. The exports of France he computes at L. 5,000,000, of which one-fourth came to Britain; of Holland L. 18,000,000, of which L. 300,000 came to Britain. The money raiſed yearly by the king of France was about L. 6,500,000 Sterling; that of all the Dutch provinces L. 3,000,000, of which 2,100,000 was raiſed in Holland and Zealand. The number of people in England he computed to be ſix millions, and their expences, at L. 7 *per annum* a head, L. 42,000,000; the rent of land L. 8,000,000; and the intereſts, &c. of perſonal eſtates as much, the rents of houſes L. 4,000,000, and the profits of labour L. 26,000,000. The people of Ireland he reckoned 1,200,000. The corn ſpent in England, at 5*s*. a buſhel for wheat, and 2*s*. 6*d*. for barley, amounts to L. 10,000,000 a-year. The navy of England then required 36,000 men to man it, and other trade and ſhipping 48,000. In France, to manage the whole ſhipping trade, there were then required only 1500 men. The whole people of France were 13,500,000; and thoſe of England, Scotland, and Ireland, about 9,500,000. In the three kingdoms are about 20,000 churchmen, and in France more than 270,000. In the dominions of England were above 40,000 ſeamen, and in France not more than 10,000. In England, Scotland, and Ireland, and all their dependencies, there was then about 60,000 ton of ſhipping, worth about 4,500,000 in money. The ſea-line round England, Scotland, and Ireland, and the adjacent iſles, is about 3800 miles. In the whole world he reckoned about 350,000,000 of people; and thoſe with whom the Engliſh and Dutch have any commerce, not more than eighty millions; and the value of commodities

commodities annually traded for in the whole not above L. 45,000,000. That the manufactures exported from England amounted to about L. 5,000,000 *per annum;* lead, tin, and coals, to L. 500,000 *per annum.* The value of the French commodities then brought into England did not exceed L. 1,200,000 *per annum;* and the whole cash of England in current money was then about L. 6,000,000 Sterling.

With these calculations Dr Davenant was dissatisfied; and therefore, from the observations of Mr Greg. King, he advanced others of his own. He reckons the land of England 39 millions of acres; the number of people 5 millions and a half, increasing 9000 a year, making allowance for wars, plagues, and other accidents. He reckons the inhabitants of London 530,000; of other cities and market-towns in England 870,000; and those of villages, &c. 4,100,000. The yearly rent of land he reckons L. 10,000,000; of houses, &c. 2,000,000; the produce of all kinds of grain in a tolerable year L. 9,075,000; the annual rent of corn lands L. 2,200,000, and their net produce L. 9,000,000; the rent of pasture, meadows, woods, forests, commons, heaths, &c. L. 7,000,000; the annual produce by cattle in butter, cheese, and milk, about L. 2,500,000; the value of the wool yearly shorn about L. 2,000,000; of horses yearly bred about L. 250,000; of the flesh yearly spent as food about L. 3,350,000; of the tallow and hides about L. 600,000; of the hay yearly consumed by horses about L. 1,300,000; of the hay consumed by other cattle L. 1,000,000; of the timber yearly felled for building L. 500,000; and of the wood yearly spent in firing, &c. about L. 500,000. The proportion of the land of England to its inhabitants is now about $7\frac{1}{4}$ acres per head; the value of the wheat, rye, and barley, necessary for the sustenance of England, amounts to at least L. 6,000,000 Sterling *per annum;* of the woollen manufacture about L. 8,000,000 *per annum,* and exports of all kinds of the woollen manufacture amount to above L. 2,000,000 *per annum;* the annual income of England, on which the whole people subsist, and out of which all taxes are paid, is reckoned to be about L. 43,000,000, that of France L. 81,000,000, and of Holland L. 18,250,000. See Davenant's *Essay on Trade*, in vol. vi. of his works. For calculations respecting mortality, see Major Grant's *Observations on the Bills of Mortality*, and our article *Bills of Mortality.*

In Vol. XLIX. of the Philosophical Transactions we have an estimate of the number of people in England by Dr Brakenridge, from considering the number of houses and quantity of bread consumed. On the former principle he computes the number of people to be 6,257,418 of all ages, counting in England and Wales 911,310 houses, and allowing six persons to a house. From a survey of the window-lights after the year 1750, the number of houses charged in England and Wales were 690,000, besides 200,000 cottages that pay nothing; the whole number therefore was 890,000, and the number of people, allowing six to a house, 5,340,000. On the latter principle, he estimates the number of quarters of wheat consumed at home to be 2,026,100; and allowing a quarter for three persons in a year, or seven ounces a day for each person, he concludes the number of people to be 6,078,300. Of this number, according to Dr Halley's rule, he supposes about 1,500,000 men able to carry arms. The country he supposes capable of supporting one-half more inhabitants, or 9,000,000; for, according to Mr Templeman's survey, England contains 49,450 square miles, that is, 31,648,000 acres, of which 25,300,000 acres are proper to be cultivated; and allowing three acres, well manured, for the maintenance of one person, there will be maintenance in England for 8,430,000 people; to which add the produce of fishing, and it will enable the country to support 9,000,000. In Ireland, Mr Templeman reckons 17,536,000 acres, of which Dr Brakenridge thinks 12,000,000 are capable of cultivation; and allowing four acres to each person, and the number of inhabitants to be only 1,000,000, Ireland could maintain 2,000,000 more people than it has now. In Scotland, containing 1,500,000 people, and 17,728,000 acres of land, of which there are 11,000,000 good acres, allowing five for each person, he supposes there may be provision for 2,200,000 people, or for 700,000 more than there are at present. Hence he infers, that were both the British isles properly cultivated, there is a provision for 6,000,000 inhabitants beyond the present number. Extending his survey to the whole globe, he supposes the whole surface to be to the quantity of land as 8 to 3, *i. e.* as 197,819,550 to 74,182,331 square miles; out of which, deducting one-third for waste-ground, there will be 49,454,887 square miles, or 31,651,127,680 good acres. And stating the whole number of inhabitants on the globe to be 400,000,000, there will be 79 good acres to each person. See Dr Halley's *Calculations* on the same subject, and *Dr Price's* (for a list of whose works see his life at the word Price), and King *on the National Debt.*

POLITICS, the first part of economy or ethics, consisting in the well governing and regulating the affairs of a state for the maintenance of the public safety, order, tranquillity, and morals.

Lord Bacon divides politics into three parts, viz. the *preservation* of the state, its *happiness* and *flourishing*, and its *enlargement.* Of the first two, he informs us, various authors have treated, but the last has never been handled; and he has given a specimen of an essay to supply the want.

POLITY, or Policy, denotes the peculiar form and constitution of the government of any state or nation; or the laws, orders, and regulations, relating thereto *.——Polity differs only from politics, as the theory from the practice of any art.

* See *Government.*

Of the nature of our social duties, both private and political, we have already spoken at some length (see *Moral Philosophy*, Part II. chap. iii. and particularly sect. vii.); and we shall have occasion to take a view of the origin and nature of the several political establishments of Europe, &c. hereafter. (See *Civil Society.*) We shall only further remark in this place upon the necessity of always joining politics and morality together. This view of the subject is indeed antiquated and neglected; but the connection has always been externally respected even by those who have separated them the most widely. Politics and morality, far from standing in opposition to each other, have the most intimate connection, and exhibit the relation which the *part* bears to the *whole;* that is to say, that politics are only a part or a branch of morality. No truth can be more evident than this; for

for as morality is the guide of human life, the principle of order, and the univerſal ſource of real improvement and genuine happineſs to all mankind, every thing relative to the direction of individuals, or the government of nations, muſt be comprehended within its ſphere, and be ſubſervient to its laws. All the ſchemes and projects of pretended political wiſdom, that deviate from or violate the rules of this maſter-ſcience, turn out in the iſſue often to the detriment of their contrivers, always to that of the nation; and it is a palpable and abſurd error to think of advancing the happineſs of one country at the expence of the general good of mankind. The experience of ages, and the hiſtory of the world, confirm theſe aſſertions; from which, and from daily obſervation, we obtain a convincing proof of the wiſdom of the good old maxim, both in its application to individuals and to nations, that "honeſty is the beſt policy." See Baron Dahlberg's *Conſiderations on the Connection between Morality and Politics*, read by himſelf to the Academy of Sciences at Erfurt.

POLL, a word uſed in ancient writings for the head: hence to poll, is either to vote, or to enter down the names of thoſe perſons who give their votes at an election.

Poll-Evil. See Farriery, § xxxii.

Poll-Money, or *Capitation*, a tax impoſed by authority of parliament on the perſon or head; either on all indifferently, or according to ſome known mark or diſtinction, as quality, calling, &c.

Thus, by the ſtatute 18 Car. II. every ſubject in the kingdom was aſſeſſed by the head, or poll, according to his degree; every duke L. 100, marquis L. 80, baronet L. 30, knight L. 20, eſquire L. 10, &c. and every ſingle private perſon 12d.

This was no new tax, as appears by former acts of parliament.

POLLACHIUS, or Pollack. See Gadus.

POLLARD, or Crocard, the name of a ſort of baſe money current in Ireland in the time of Edward I. See *Simon's Hiſtory of Iriſh Coins*, p. 15.

POLLEN, the fecundating or fertilizing duſt contained within the antheræ or tops of the ſtamina, and diſperſed upon the female organ when ripe for the purpoſes of impregnation. See Botany.

This duſt, correſponding to the ſeminal fluid in animals, is commonly of a yellow colour; and is very conſpicuous in the ſummits of ſome flowers, as the tulip and lily. Its particles are very minute, and of extreme hardneſs. Examined by the microſcope, they are generally found to aſſume ſome determinate form, which often predominates, not only through all the ſpecies of a particular genus, but alſo through the genera of a natural family or order. The powder in queſtion being triturated, and otherwiſe prepared in the ſtomach of bees, by whom great quantities are collected in the hairy bruſhes with which their legs are covered, is ſuppoſed by ſome authors to produce the ſubſtance known by the name of *wax*; a ſpecies of vegetable oil, rendered concrete by the preſence of an acid, which muſt be removed before the ſubſtance can be rendered fluid.

POLLENTIA, a town or colony of Roman citizens in the Balearis Major. It is now ſaid to be Alcudia, ſituated on the north-eaſt ſide of the iſland Majorca. There was another *Pollentia* of the Picenum, likewiſe a colony. It is thought to be either the ſame with or near to the Urbs Salvia, but is now extinct. There was a third of Liguria, ſituated at the confluence of the Stura and Tanarus. Suetonius calls it a municipium, and the people *Pollentina Plebs*. It was famous for its abundance of black fleeces; but was afterwards, under Arcadius and Honorius, ſtained with a defeat rather of the Romans under Stilico than of the Goths under Alaricus, though palliated by Claudian the poet; after which Rome was taken and ſet on fire. It is now called *Solenza*, a ſmall town of Piedmont, not far from Aſti.

POLLEX, in anatomy, denotes either the thumb or great toe, according as *manus* or *pedis* is added to it.

POLLICHIA, in botany: A genus of the monogynia order, belonging to the monandria claſs of plants; and in the natural method ranking with thoſe that are doubtful. Of this there is only one ſpecies, *viz.* the *campeſtris*, or whorl-leaved pollichia, a native of the Cape of Good Hope, and flowers in September.

POLLICIPES, the toe-shell, in natural hiſtory, is the name of a genus of ſhells, the characters of which are theſe: they are multivalve flat ſhells, of a triangular figure, each being compoſed of ſeveral laminæ, which end in a ſharp point. They ſtand upon pedicles, and are furniſhed with a great number of hairs. We have only one known ſpecies of this genus, which is always found in large cluſters.

POLLICIS pressio, and Pollicis versio, were uſed at the combats of gladiators as ſignals of life or death to the vanquiſhed combatant; or to the victor to ſpare or take the life of his antagoniſt. The *pollicis preſſio*, by which the people granted life to the proſtrate gladiator, was no more than a clenching of the fingers of both hands together, and ſo holding the two thumbs upright cloſe together. The *pollicis verſio*, which authoriſed the victor to kill the other as a coward, was the bending back of the thumbs. Such is Dacier's opinion; but others ſay the *pollicis preſſio* was when the people held up one hand with the thumb bent, and the *pollicis verſio* when they ſhowed the hand with the thumb raiſed. Authors, however, are not perfectly agreed, though the phraſes *pollicem premere*, and *pollicem vertere*, frequently occur in the Latin claſſics as indications of the people's will that a gladiator ſhould live or die.

POLLIO (Caius Aſinius), a celebrated Latin poet and orator, was of conſular dignity, and compoſed ſome tragedies which were eſteemed, but are now loſt. He was the firſt who opened at Rome a library for the uſe of the public. He was the friend of Mark Antony; which prevented his complying with the ſolicitations of Auguſtus, who preſſed him to embrace his party. At length Auguſtus having wrote ſome verſes againſt Pollio, he was urged to anſwer them: on which he ſaid, "I ſhall take care of writing againſt a man who has the power of proſcribing us." He is praiſed by Virgil and Horace, whoſe patron he was.

There was another *Pollio*, a friend of Auguſtus, who uſed to feed his fiſhes with human fleſh. This cruelty was diſcovered when one of his ſervants broke a glaſs in the preſence of Auguſtus, who had been invited to a feaſt. The maſter ordered the ſervant to be ſeized, but he threw himſelf at the feet of the emperor, and begged him to interfere, and not to ſuffer him to be devoured by fiſhes. Upon this the cauſes of his apprehenſion

on, were examined; and Auguftus, aftonifhed at the barbarity of his favourite, caufed the fervant to be difmiffed, all the fifh ponds to be filled up, and the cryftal glaffes of Pollio to be broken to pieces.

POLLUTION, in general, fignifies defilement, or the rendering a perfon or place unclean or unholy. For the Jewifh pollutions, fee the article IMPURITY.

The Romanifts hold a church to be polluted by the effufion of blood or of feed therein: and that it muft be confecrated anew. And the Indians are fo fuperftitious on this head, that they break all the veffels which thofe of another religion have drank out of, or even only touched; and drain all the water out of a pond in which a ftranger has bathed.

POLLUTION, in medicine, a difeafe which confifts in an involuntary emiffion of the feed in time of fleep. This, in different perfons, is very different in degree; fome being affected with it only once in a week, a fortnight, three weeks, or a month, and others being fubject to it almoft every night. The perfons moft fubject to it, are young men of a fanguineous temperament, who feed high and lead a fedentary life. When this happens to a perfon but once in a fortnight or a month, it is of no great confequence; but when it happens almoft every night, it greatly injures the health; the patient looks pale and fickly; in fome the eyes become weak and inflamed, are fometimes affected with violent defluctions, and are ufually at laft encircled with a livid appearance of the fkin. This diftemper is to be cured rather by a change of life than by medicines. When it has taken its rife from a high diet and a fedentary life, a coarfer food and the ufe of exercife will generally cure it. Perfons fubject to this difeafe fhould never take any ftimulating purges, and muft avoid as much as poffible all violent paffions of the mind: and though exercife is recommended in moderation, yet if this be too violent, it will rather increafe the diforder than contribute to its cure.

Self-POLLUTION. See ONANISM.

POLLUX (Julius), a Greek writer of antiquity, flourifhed in the reign of the emperor Commodus, and was born at Naucrates, a town in Egypt. He was educated under the fophifts, and made great progrefs in grammatical and critical learning. He taught rhetoric at Athens, and became fo famous that he was made preceptor of the emperor Commodus. He drew up for his ufe, and infcribed to him, while his father Marcus Antoninus was living, an *Onomafticon* or Greek Vocabulary, divided into ten books. It is extant, and contains a vaft variety of fynonymous words and phrafes, agreeably to the copioufnefs of the Greek tongue, ranged under the general claffes of things. It was intended to facilitate the knowledge of the Greek language to the young prince; and it is ftill very ufeful to all who have a mind to be perfect in it. The firft edition of it was printed at Venice by Aldus in 1502, and a Latin verfion was afterwards made and publifhed with it: but there was no correct and handfome edition of it till that of Amfterdam, 1706, in folio, by Lederlinus and Hemfterhufius. Lederlinus went through the firft feven books, correcting the text and verfion, and fubjoining his own, with the notes of Salmafius, If. Voffius, Valefius, and of Kuhnius, whofe fcholar he had been, and whom he fucceeded in the profefforfhip of the oriental languages in the univerfity of Strafburg. Hemfterhufius continued the fame method through the three laft books: this learned man has fince diftinguifhed himfelf by an excellent edition of Lucian, and other monuments of folid and profound literature.

Pollux || Polyænus.

Pollux wrote many other things, none of which remain. He lived to the age of 58. Philoftratus and Lucian have treated him with much contempt and ridicule. *Philoftrat. de vit. Sophift.* lib. ii. and *Lucian in Rhetorum præceptore.*

POLLUX. See CASTOR and POLLUX.

POLLUX, in aftronomy, a fixed ftar of the fecond magnitude in the conftellation Gemini, or the Twins. See CASTOR.

POLLUX and Caftor, a fiery meteor. See *CASTOR and Pollux.*

POLOCSKI, a palatinate in the duchy of Lithuania, bounded on the north by the palatinate of Weytepfki, on the fouth by the Dwina, on the north by Mufcovy, and on the weft by Livonia. It is a defert country full of wood, and had formerly its own dukes.

POLOCSKI, a town of Lithuania, and capital of a palatinate of the fame name, with two caftles to defend it. It was taken by the Mufcovites in 1563, and retaken the fame year. It is feated on the river Dwina, 50 miles fouth-weft of Weytepfki, and 80 eaft of Braflaw. E. Long. 29. 0. N. Lat. 56. 4.

POLTROON, or POLTRON, a coward or daftard, wanting courage to perform any thing great or noble. The word is borrowed from the French, who according to Salmafius, derive it *a pollice truncato;* becaufe anciently thofe who would avoid going to the wars cut off their thumb. But Menage, with more probability, derives it from the Italian *poltrone*, and that from *poltro* a "bed;" becaufe timorous, pufillanimous people take pleafure in lying a-bed. Others choofe to derive the word from the Italian *poltro* a "colt;" becaufe of that creature's readinefs to run away.

POLVERINE, the calcined afhes of a plant; of a fimilar nature with our pot-afhes or pearl-afhes. It is brought from the Levant and Syria; and in the glafstrade it is always to be preferred to any other afhes. The barilla, or pot-afhes of Spain, yield more pure falt than the polverine of the Levant, but the glafs made with it has always fome blue tinge: that made with the polverine is perfectly white, which ought always to be ufed for the fineft cryftal.

POLYADELPHIA (from πολυς *many*, and αδελφια *brotherhood)*, many brotherhoods. The name of the 18th clafs of Linnæus's fexual fyftem, confifting of plants with hermaphrodite flowers, in which feveral ftamina or male organs are united by their filaments into three or more diftinct bundles.

POLYÆNUS, the name of many famous men recorded in ancient writers. Among them was Julius Polyænus, of whom we have fome Greek epigrams extant in the firft book of the *Anthologia.* The Polyænus whom it moft concerns us to know about, is the author of the eight books of the Stratagems of illuftrious Commanders in War. He was probably a Macedonian, and perhaps a foldier in the early part of his life; but of this there is no certainty. He was undoubtedly a rhetorician and a pleader of caufes; and appears, from the dedication of his work to the emperors Antoninus and Verus, to have lived towards the latter part of the fecond century. The *Stratagemata* were publifhed in

in Greek by Isaac Casaubon, with notes, in 1589, 12mo; but no good edition of them appeared till that of Leyden, 1690, in 8vo. The title-page runs thus: *Polyæni Stratagematum libri octo, Justo Vulteio interprete, Pancratius Maasvicius recensuit, Isaaci Casauboni nec non suas notas adjecit.*

We have in this work the various stratagems of above 300 captains and generals of armies, chiefly Greeks and barbarians: for the Romans seldom used such finesses; and Polyænus has shown further, that he was not well versed in Roman affairs. A great number of these stratagems appear to us to be ridiculous or impracticable; and neither the generals, nor even common soldiers of our days, would be found simple enough to be caught by them. Few of this order are capable of reading *Polyænus's Stratagems*; and if they were, they would reap little benefit from it. The book is useful to such as study the Greek language and antiquity; for many things will be found in it, illustrating the customs and opinions of ancient times. The sixth and seventh books are imperfect.

Polyænus composed other works besides the *Stratagemata*. Stobœus has produced some passages out of a book *De Republica Macedonum*; and Suidas mentions a piece concerning the Thebans and three books of Tacitus. If death had not prevented, he would have written *Memorabilia of the Emperors Antoninus and Verus*: for he makes a promise of this in the preface to his sixth book of *Stratagems*. Casaubon, in the dedication of Polyænus to Mornæus, calls him *an elegant, acute, and learned writer*.

POLYANDRIA (from πολυς *many*, and ανηρ a *man* or *husband)*, many husbands. The name of the 13th class in Linnæus's sexual method, consisting of plants with hermaphrodite flowers, which are furnished with several stamina, that are inserted into the common receptacle of the flower.

POLYANTHEA, a collection of common-places in alphabetical order, for the use of orators, preachers, &c. The word is formed from the Greek πολυς *much*, and ανθος *flower*; and has much the same meaning with *anthology* or *florilege*. The first author of the polyanthea was Dominic Nanni de Mirabellio, whose labour has been improved on by Barth. Amantius, and Franc. Torsius; and since these, by Jos. Langius, under the title of *Polyanthea nova*, 1613.

POLYANTHUS, in botany. See PRIMULA.

POLYBIUS, a famous Greek historian, was born at Megalopolis, a city of Arcadia, 205 years before Christ; and was the son of Lycortas, chief of the republic of the Achæans. He was trained to arms under the celebrated Philopœmen, and is described by Plutarch carrying the urn of that great but unfortunate general in his funeral procession. He arose to considerable honours in his own country, but was compelled to visit Rome with other principal Achæans, who were detained there as pledges for the submission of their state. From hence he became intimate with the second Scipio Africanus, and was present with him at the demolition of Carthage. He saw Corinth also plundered by Mummius, and thence passing through the cities of Achaia, reconciled them to Rome. He extended his travels into Egypt, France, and Spain, that he might avoid such geographical errors as he has censured in others.

It was in Rome that he composed his excellent history, for the sake of which his travels were undertaken. This history was divided into 40 books; but there only remains the five first, with extracts of some parts of the others. It has had several editions in Greek and Latin; and there is an English translation by Mr Hampton. He died at the age of 82.

POLYCARP, one of the most ancient fathers of the Christian church, was born towards the end of the reign of Nero, probably at Smyrna; where he was educated at the expence of Calista, a noble matron distinguished by her piety and charity. He was unquestionably a disciple of St John the Evangelist, and conversed familiarly with other of the apostles. When of a proper age, Bucolus ordained him a deacon and catechist of his church; and upon his death he succeeded him in the bishopric, to which he is said to have been consecrated by St John, who also directed his Apocalypse, among others, to him, under the title of *the angel of the church of Smyrna*. At length the controversy about the observation of Easter beginning to grow high between the eastern and western churches, he went to Rome to discourse with those who were of the opposite party. The see was then possessed by Anicetus, with whom he had many conferences, that were carried on in the most peaceable and amicable manner; and though neither of them could bring the other to embrace his opinion, they both retained their own sentiments without violating that charity which is the great law of their religion.

Whilst at Rome he particularly opposed the heresies of Marcian and Valentinus. His conduct on this occasion is related by Irenæus; who informs us, that when Polycarp passed Marcian in the street without speaking, Marcian said, "Polycarp, own us!" To which he replied with indignation, "I own thee to be the first-born of Satan." Irenæus adds, that when any heretical doctrines were spoken in his presence, he would stop his ears and say, "Good God! to what times hast thou reserved me, that I should hear such things!" and immediately left the place. He was wont to tell, that St John, going into a bath at Ephesus, and finding Cerinthus the heretic in it, immediately started back without bathing, crying out, "Let us run away, lest the bath should fall upon us while Cerinthus the enemy of truth is in it." Polycarp governed the church of Smyrna with apostolic purity, till he suffered martyrdom in the 7th year of Marcus Aurelius; the manner of which is thus related.

The persecution waxing hot at Smyrna, and many having sealed their faith with their blood, the general cry was, "Away with the impious; let Polycarp be sought for." Upon which he privately withdrew into a neighbouring village, where he continued for some time praying night and day for the peace of the church. He was thus employed, when one night he fell into a trance, and dreamed that his pillow took fire, and was burnt to ashes; which, when he awoke, he told his friends was a presage that he should be burnt alive for the cause of Christ. Three days afterwards, in order to escape the incessant search for him, he retired into another village: his enemies, however, were at hand, who seized upon two youths (one of whom they forced by stripes to a confession), by whom they were conducted to his lodging. He might have saved himself by getting into another house; but he submitted, saying, "The will of the Lord be done." He therefore came

down from his bed-chamber, and faluting his perfecutors with a ferene and cheerful countenance, he ordered a table to be fet with provifions, invited them to partake of them, and only requefted for himfelf one hour for prayer; after which he was fet upon an afs, and conducted towards Smyrna. On the road he met Herod an irenarch or juftice of the province, and his father, who were the principal inftigators of the perfecution. Herod took him up into his chariot, and ftrenuoufly endeavoured to undermine his conftancy; but having failed in the attempt, he thruft him out of the chariot with fo much violence and indignation, that he bruifed his thigh with the fall. When at the place of execution, there came, as is faid, a voice from heaven, faying, "Polycarp, be ftrong, and quit thyfelf like a man." Before the tribunal he was urged to fwear by the genius of Cæfar. "Repent (fays the proconful), and fay with us, take away the impious." Whereupon the martyr looking round at the crowd with a fevere and angry countenance, beckoned with his hand, and looking up to heaven, faid with a figh, in a very different tone from what they meant, "Take away the impious." At laft, confeffing himfelf to be a Chriftian, the crier thrice proclaimed his confeffion, and the people fhouted, "This is the great doctor of Afia, and the father of the Chriftians; this is the deftroyer of our gods, that teaches men not to do facrifice, or worfhip the deities." When the fire was prepared, Polycarp requefted not to be nailed, as ufual, but only tied to the ftake; and after a fhort prayer, which he pronounced with a clear and audible voice, the executioner blew up the fire, which increafing to a mighty flame, "Behold a wonder feen (fays my author) by us who were purpofely referved, that we might declare it to others; the flames difpofing themfelves into the refemblance of an arch, like the fails of a fhip fwelled with the wind, gently encircled the body of the martyr, who ftood all the while in the midft, not like roafted flefh, but like the gold or filver purified in the furnace, his body fending forth a delightful fragrancy, which, like frankincenfe or fome other coftly fpices, prefented itfelf to our fenfes. The infidels, exafperated by the miracle, commanded a fpearman to run him through with a fword: which he had no fooner done, but fuch a vaft quantity of blood flowed from the wound as extinguifhed the fire; when a dove was feen to fly from the wound, which fome fuppofe to have been his foul, clothed in a vifible fhape at the time of its departure (A)." The Chriftians endeavoured to carry off his body entire, but were not allowed by the irenarch, who commanded it to be burnt to afhes. The bones, however, were gathered up, and decently interred by the Chriftians.

Thus died St Polycarp, the 7th of the kalends of May, A. C. 167. The amphitheatre on which he fuffered was moftly remaining not many years ago; and his tomb, which is in a little chapel in the fide of a mountain, on the fouth-eaft of the city, was folemnly vifited by the Greeks on his feftival day; and for the maintenance and repairing of it, travellers were wont to throw a few afpers into an earthen pot that ftands there for the purpofe. He wrote fome homilies and epiftles, which are now loft, except that to the Philippians, which is a truly pious and Chriftian piece, containing fhort and ufeful precepts and rules of life, which St Jerome informs us was even in his time read in the public affemblies of the Afiatic churches. It is fingularly ufeful in proving the authenticity of the books of the New Teftament; for he has feveral paffages and expreffions from Matthew, Luke, the Acts, St Paul's Epiftles to the Philippians, Ephefians, Galatians, Corinthians, Romans, Theffalonians, Coloffians, 1ft Timothy, 1ft Epiftle of St John, and 1ft of Peter; and makes particular mention of St Paul's Epiftle to the Ephefians. Indeed his whole Epiftle confifts of phrafes and fentiments taken from the New Teftament (B).

POLYCARPON, in botany: A genus of the trigynia order, belonging to the triandria clafs of plants; and in the natural method ranking under the 22d order, *Caryophyllei*. The calyx is pentaphyllous; there are five very fmall ovate petals; the capfule is unilocular and trivalved.

POLYCHREST, in pharmacy, fignifies a medicine that ferves for many ufes, or that cures many difeafes.

Sal POLYCHREST, a compound falt made of equal parts of faltpetre and fulphur, deflagrated in a red-hot crucible.

POLYCNEMUM, in botany: A genus of the monogynia order, belonging to the triandria clafs of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. The calyx is triphyllous; and there are five calciform petals, with one feed almoft naked.

POLYCRATES, was a tyrant of Samos, famous for the good fortune which always attended him. He became very powerful; and got poffeffion not only of the neighbouring iflands, but alfo of fome cities on the coaft of Afia. He had a fleet of 100 fhips of war, and was fo univerfally efteemed, that Amafis the king of Egypt made a treaty of alliance with him. The Egyptian king was, however, afraid of his continued profperity, and advifed him to chequer his enjoyments, by relinquifhing fome of his moft favourite objects. Polycrates, in compliance, threw into the fea a beautiful feal, the moft valuable of his jewels. The lofs of fo precious a feal afflicted him for fome time; but foon after he received as a prefent a large fifh, in whofe belly it was found. Amafis no fooner heard this, than he gave up all alliance with the tyrant of Samos, and obferved, that fooner or later his good fortune would vanifh. Some time after Polycrates vifited Magnefia on the Mæander, where he had been invited by Orontes the governor. Here he was fhamefully put to death, merely becaufe the governor wifhed to terminate his profperity. The

(A) The miraculous part of this account is ridiculed by Dr Middleton in his Free Enquiry and Defence of it; but fomething is offered in its favour by Mr Jortin, who obferves, "the circumftances are fufficient only to create a paufe and a doubt." *Remarks on Eccl. Hift.* vol. i.

(B) Jortin, vol. i. p. 68. who to the particulars made out by Cotelerius, has added one from Galat. iv. 26. and another from Hebr. iv. 12, 13.

daughter of Polycrates had diſſuaded her father from going to the houſe of Orontes, on account of the bad dreams which ſhe had, but in vain.

POLYCROTA, in the naval architecture of the ancients, is a word uſed to expreſs ſuch of their galleys as had three, four, five, or more tiers of rowers, ſeated at different heights; they were diſtinguiſhed by this term from the *monocrota*, or thoſe which had only ſingle rows of oars. The number of rows of rowers in the polycrote galleys has given occaſion to ſome to ſuppoſe thoſe veſſels of ſuch a height from the water as is ſcarce credible. Commentators are not at all agreed upon the conſtruction of theſe veſſels.

POLYDAMAS, was a famous athlete, who imitated Hercules in whatever he did. He killed a lion with his fiſt, and it is reported he could ſtop a chariot with his hand in its moſt rapid courſe. He was one day with ſome of his friends in a cave, when on a ſudden a large piece of rock came tumbling down, and while all fled away he attempted to receive the falling fragment in his arms. His prodigious ſtrength, however, was inſufficient, and he was inſtantly cruſhed to pieces under the rock.

POLYDECTES, a ſon of Magnes, was king of the iſland of Seriphos. He received with great kindneſs Danae and her ſon Perſeus, who had been expoſed on the ſea by Acriſius. He took great care of the education of Perſeus; but becoming enamoured of Danae, he removed her from his kingdom, apprehenſive of his reſentment. He afterwards paid his addreſſes to Danae; and being rejected, he prepared to offer her violence. Danae fled to the altar of Minerva for protection; and Dictys, the brother of Polydectes, who had himſelf ſaved her from the ſea-waters, oppoſed her raviſher, and armed himſelf in her defence. At this critical moment Perſeus arrived; and with Meduſa's head he turned into ſtones Polydectes, with the aſſociates of his guilt. The crown of Seriphos was given to Dictys, who had ſhown himſelf ſo active in the cauſe of innocence.

POLYDORE VIRGIL. See VIRGIL.

POLYDORUS, a ſon of Priam by Hecuba, or, according to others, by Laothoe, the daughter of Altes, king of Pedaſus. Being young and inexperienced when Troy was beſieged by the Greeks, his father removed him to the court of Polymneſtor, king of Thrace, to whoſe care he entruſted the greateſt part of his treaſures, till his country ſhould be freed from foreign invaſion. On the death of Priam, Polymneſtor made himſelf maſter of the riches which were in his poſſeſſion; and to enſure them the better, he murdered the young prince, and threw his body into the ſea, where it was found by Hecuba. According to Virgil, his body was buried near the ſhore by his aſſaſſin; and there grew on his grave a myrtle, whoſe boughs dropped blood, when Æneas going to Italy, attempted to tear them from the tree.

POLYGALA, MILKWORT: A genus of the octandria order, belonging to the diadelphia claſs of plants; and in the natural method ranking under the 33d order, *Lomentaceæ*. The calyx is pentaphyllous, with two of its leaflets wing-ſhaped and coloured; the legumen is obcordate and bilocular. There are 24 ſpecies; of which the moſt remarkable are,

1. The vulgaris, or common milkwort, is a native of the Britiſh heaths and dry paſtures. The ſtalks are about five or ſix inches long, ſeveral ariſing from the ſame root: the leaves are firm, ſmooth, entire, and grow alternate upon the ſtalks, which are terminated with ſpikes of flowers, moſt commonly blue, but often red or white: the calyx conſiſts of five leaves, three of which are ſmall and green, two below, and one above the corolla; the other two intermediate ones are large, oval, flat-coloured, veined, and reſemble petals, which at length turn greeniſh, and remain a defence to the ſeed-veſſel; the corolla conſiſts of three petals folded together, and forming a tube: the carina is terminated by a kind of heart-ſhaped, concave appendage, fringed at the extremity. The root of this plant has a bitter taſte, and has been found to poſſeſs the virtues of the American rattleſnake-root. It purges without danger, and is alſo emetic and diuretic; ſometimes operating all the three ways at once. A ſpoonful of the decoction made by boiling an ounce of the herb in a pint of water till one half has exhaled, has been found ſerviceable in pleuriſies and fevers, by promoting a diaphoreſis and expectoration; and three ſpoonfuls of the ſame, taken once an hour, has proved beneficial in the dropſy and anaſarca. It has alſo been found ſerviceable in conſumptive complaints.

2. The ſenega, or ſeneka, rattleſnake-wort, grows naturally in moſt parts of North America. This hath a perennial root compoſed of ſeveral fleſhy fibres, from which ariſe three or four branching ſtalks which grow erect, garniſhed with ſpear-ſhaped leaves placed alternately. The flowers are produced in looſe ſpikes at the end of the branches: they are ſmall, white, and ſhaped like thoſe of the common ſort. It flowers here in July, but the plants do not produce ſeeds. The root of this ſpecies operates more powerfully than the laſt; but beſides the virtues of a purgative, emetic, and diuretic, it has been recommended as an antidote againſt the poiſon of a rattleſnake; but this opinion is now exploded. It ſtill, however, maintains its character in ſeveral diſorders. Its efficacy, particularly in pleuriſies, is moſt fully eſtabliſhed in Virginia: formerly near 50 out of 100 died of that diſtemper, but by the happy uſe of this root hardly three out of the ſame number have been loſt.

As the ſeeds of the rattleſnake-wort ſeldom ſucceed even in the countries where the plant is a native, the beſt method of propagating it is to procure the roots from America, and plant them in a bed of light earth in a ſheltered ſituation, where they will thrive without any other culture than keeping them free from weeds. But though the plant will ſtand out ordinary winters, it will be proper to cover it during that ſeaſon with old tanner's bark, or other mulch, to keep out the froſt.

POLYGAMIA (πολυς *many*, and γαμος *marriage*). This term, expreſſing an intercommunication of ſexes, is applied, by Linnæus, both to plants and flowers. A polygamous plant is that which bears both hermaphrodite flowers and male or female, or both.

POLYGAMY, a plurality of wives or huſbands, in the poſſeſſion of one man or woman at the ſame time.

Polygamy is ſo univerſally eſteemed unlawful, and even unnatural, through Europe, and in all Chriſtian countries, that we have generally reaſoned upon this conviction. Both religion and reaſon appear at firſt ſight at leaſt to condemn it; and with this view of the ſubject

ygamy fubject mankind in general reſt ſatisfied: but ſome bolder geniuſes have taken the oppoſite ſide of the queſtion; have caſt off the prejudices of education, and attempted to ſhow that polygamy is not unlawful, but that it is juſt and neceſſary, and would be a public benefit. Such writers, to uſe the words of an intelligent critic *, "recur to the common ſubterfuge, of which every *ſetter up of ſtrange gods*, and every CONSCIENTIOUS troubler of the public peace, have artfully availed themſelves to ſilence the clamour of expoſtulation. 'TRUTH! TRUTH!' is their general cry: and with this hopeful pretence, prudence and humility, and every amiable and uſeful virtue, are left behind; while CONSCIENCE *(conſcience!)* blindly ruſhes forward to oppoſe order, inſult authority, and overturn the cuſtoms of ages."

Tontbly iew, 63. 74.

But notwithſtanding theſe fair pretences, it will, we doubt not, be eaſy to ſhow that truth is not upon their ſide; prudence and delicacy are certainly at open war with them: for Dr Percival, Phil. Tranſ. vol. lxvi. part i. p. 163. has very juſtly obſerved, that the practice is brutal, deſtructive to friendſhip and moral ſentiment, inconſiſtent with one great end of marriage, the education of children, and ſubverſive of the natural rights of more than half of the ſpecies. Beſides, it is injurious to population, and therefore can never be countenanced or allowed in a well-regulated ſtate; for though the number of females in the world may conſiderably exceed the number of males, yet there are more men capable of propagating their ſpecies than women capable of bearing children; and it is a well-known fact, that Armenia, in which a plurality of wives is not allowed, abounds more with inhabitants than any other province of the Turkiſh empire.

Indeed it appears, that in ſome countries where it is allowed, the inhabitants do not take advantage of it. "The Europeans (ſays M. Niebuhr †) are miſtaken in thinking the ſtate of marriage ſo different among the Muſſulmans from what it is with Chriſtian nations. I could not diſcern any ſuch difference in Arabia. The women of that country ſeem to be as free and as happy as thoſe of Europe can poſſibly be. Polygamy is permitted, indeed, among Mahometans, and the delicacy of our ladies is ſhocked at this idea; but the Arabians rarely avail ‡ themſelves of the privilege of marrying four lawful wives, and entertaining at the ſame time any number of female ſlaves. None but rich voluptuaries marry ſo many wives, and their conduct is blamed by all ſober men. Men of ſenſe, indeed, think this privilege rather troubleſome than convenient. A huſband is by law obliged to treat his wives ſuitably to their condition, and to diſpenſe his favours among them with perfect equality: but theſe are duties not a little diſagreeable to moſt Muſſulmans; and ſuch modes of luxury are too expenſive to the Arabians, who are ſeldom in eaſy circumſtances. I muſt, however, except one caſe; for it ſometimes happens that a man marries a number of wives in the way of commercial ſpeculation. I know a Mullah, in a town near the Euphrates, who had married four wives, and was ſupported by the profits of their labour."

† Heron's Tranſlation of Niebuhr's Travels.

‡ See Hindoſtan, n° 9.

See a curious kind of polygamy under the article NAYRES. The ancient Britons, too, had a kind of polygamy among them, 12 women being common to 12 men.

Selden has proved, in his *Uxor Hebraica*, that plurality of wives was allowed of, not only among the Hebrews, but alſo among all other nations, and in all ages. It is true, the ancient Romans were more ſevere in their morals, and never practiſed it, though it was not forbid among them: and Mark Antony is mentioned as the firſt who took the liberty of having two wives.

From that time it became pretty frequent in the empire till the reigns of Theodoſius, Honorius, and Arcadius, who firſt prohibited it by expreſs law in 393. After this the emperor Valentinian, by an edict, permitted all the ſubjects of the empire, if they pleaſed, to marry ſeveral wives; nor does it appear, from the eccleſiaſtical hiſtory of thoſe times, that the biſhops made any oppoſition to this introduction of polygamy. In effect, there are ſome even among the Chriſtian caſuiſts who do not look on polygamy as in itſelf criminal. Jurieu obſerves, that the prohibition of polygamy is a poſitive law; but from which a man may be exempted by ſovereign neceſſity. Baillet adds, that the example of the patriarchs is a very powerful argument in favour of polygamy: of theſe arguments we ſhall ſpeak hereafter.

It has been much diſputed among the doctors of the civil law whether polygamy be adultery. In the Roman law it is called *ſtuprum*, and puniſhed as ſuch, that is, in ſome caſes, capitally. But a ſmaller puniſhment is more conſiſtent with the Jewiſh law, wherein the prohibition of adultery is perpetual, but that of polygamy temporary only.

In Germany, Holland, and Spain, this offence is differently puniſhed. By a conſtitution of Charles V. it was a capital crime. By the laws of ancient and modern Sweden it is puniſhed with death. In Scotland it is puniſhed as perjury.

In England it is enacted by ſtatute 1 Jac. I. cap. 11. that if any perſon, being married, do afterwards marry again, the former huſband or wife being alive, it is felony, but within the benefit of clergy. The firſt wife in this caſe ſhall not be admitted as an evidence againſt her huſband, becauſe ſhe is the true wife; but the ſecond may, for ſhe is indeed no wife at all; and ſo *vice verſa* of a ſecond huſband. This act makes an exception to five caſes, in which ſuch ſecond marriage, tho' in the three firſt it is void, is, however, no felony. 1. Where either party hath been continually abroad for ſeven years, whether the party in England had notice of the other's being living or not. 2. Where either of the parties hath been abſent from the other ſeven years within this kingdom, and the remaining party hath had no notice of the other's being alive within that time. 3. Where there is a divorce or ſeparation *a menſa et thoro* by ſentence in the eccleſiaſtical court. 4. Where the firſt marriage is declared abſolutely void by any ſuch ſentence, and the parties looſed *a vinculo*. Or, 5. Where either of the parties was under the age of conſent at the time of the firſt marriage; for in ſuch caſe the firſt marriage was voidable by the diſagreement of either party, which this ſecond marriage very clearly amounts to. But if at the age of conſent the parties had agreed to the marriage, which completes the contract, and is indeed the real marriage, and afterwards one of them ſhould marry again, judge Blackſtone apprehends that ſuch ſecond marriage would be within the reaſon and penalties of the act.

Bernardus Ochinus, general of the order of Capuchins, and afterwards a Proteſtant, publiſhed, about the

middle

Polygamy. middle of the 16th century, Dialogues in favour of Polygamy, which were answered by Theodore Beza. And about the conclusion of the last century we had at London an artful treatise published in behalf of a plurality of wives, under the title of *Polygamia Triumphatrix*: the author whereof assumes the name of *Theophilus Aletheus*; but his true name was *Lyserus*. He was a native of Saxony. It has been answered by several.

A new argument in favour of polygamy has been adduced by Mr Bruce, on this principle, that in some parts of the world the proportion of female children is much greater than that of males. "From a diligent inquiry (says he) into the south and scripture-part of Mesopotamia, Armenia, and Syria, from Mousul or Nineveh to Aleppo and Antioch, I find the proportion to be fully two women to one man. There is indeed a fraction over, but it is not a considerable one. From Latikea, Laodicea *ad mare*, down the coast of Syria to Sidon, the number is nearly three, or two and three-fourths, to one man. Through the Holy Land, the country called *Horan*, in the Isthmus of Suez, and the parts of the Delta unfrequented by strangers, it is something less than three. But from Suez to the Straits of Babelmandel, which contains the three Arabias, the proportion is fully four women to one man; which I have reason to believe holds as far as the line, and 30° beyond it. The Imam of Sama was not an old man when I was in Arabia Felix in 1769; but he had 88 children then alive, of whom 14 only were sons. The priest of the Nile had 70 and odd children; of whom, as I remember, above 50 were daughters.

"It may be objected, that Dr Arbuthnot, in quoting the bills of mortality for 20 years, gave the most unexceptionable grounds for his opinion; and that my single assertion of what happens in a foreign country, without further foundation, cannot be admitted as equivalent testimony: and I am ready to admit this objection, as there are no bills of mortality in any of these countries. I shall therefore say in what manner I attained the knowledge which I have just mentioned. Whenever I went into a town, village, or inhabited place, dwelt long in a mountain, or travelled journeys with any set of people, I always made it my business to inquire how many children they had, or their fathers, their next neighbours or acquaintance. I then asked my landlord at Sidon, suppose him a weaver, how many children he has had? He tells me how many sons and how many daughters. The next I ask is a tailor, a smith, &c. in short every man who is not a stranger, from whom I can get the proper information. I say, therefore, that a medium of both sexes, arising from three or four hundred families, indiscriminately taken, shall be the proportion in which one differs from the other; and this, I am confident, will give the result to be three women in 50° of the 90° under every meridian of the globe."

Our author corroborates this argument by supposing that Mahomet perceived this disproportion, and that upon it he founded his institution allowing one man to have four wives. "With this view he enacted, or rather revived, the law which gave liberty to every individual to marry four wives, each of whom was to be equal in rank and honour, without any preference but what the predilection of the husband gave her."

Having thus established, as he supposes, the necessity of polygamy in the East, Mr Bruce proceeds to consider whether there is not some other reasons why it should not be practised in Britain farther than the mere equality in numbers of the sexes to one another. This reason he finds in the difference between the constitutions of the Europeans and eastern nations. "Women in England (says he) are capable of child-bearing at 14; let the other term be 48, when they bear no more; 34 years therefore an English woman bears children. At the age of 14 or 15 they are objects of our love; they are endeared by bearing us children after that time; and none, I hope, will pretend, that at 48 and 50 an Englishwoman is not an agreeable companion. The Arab, on the other hand, if she begins to bear children at 11, seldom or never has a child after 20. The time, then, of her child-bearing is nine years; and four women, taken altogether, have then the term of 36. So that the English woman that bears children for 34 years has only two years less than the term enjoyed by the four wives whom Mahomet has allowed; and if it be granted that an English wife may bear at 50, the terms are equal. But there are other grievous differences. An Arabian girl, at 11 years old, by her youth and beauty, is the object of man's desire: being an infant, however, in understanding, she is not a rational companion for him. A man marries there, say at 20; and before he is 30, his wife, improved as a companion, ceases to be an object of his desires and a mother of children: so that all the best and most vigorous of his days are spent with a woman he cannot love; and with her he would be destined to live 40, or 45 years, without comfort to himself by increase of family, or utility to the public. The reasons, then, against polygamy, which subsist in England, do not by any means subsist in Arabia; and that being the case, it would be unworthy of the wisdom of God, and an unevenness in his ways, which we shall never see, to subject two nations under such different circumstances absolutely to the same observances."

To all this argumentation, however, it may be replied, that whatever we may now suppose to be the constitution of nature in the warmer parts of the globe, it certainly was different at the beginning. We cannot indeed ascertain the exact position of the Garden of Eden; but it is with reason supposed not to have been far from the ancient seat of Babylon. In that country, therefore, where Mr Bruce contends that *four* women are necessary to the comfort of one man, it pleased God to grant only *one* to the first man; and that, too, when there was more occasion for population than ever there has been since, because the whole earth was to be peopled from a single pair. Matters were not altered at the flood; for Noah had but one wife. And this is the very argument used by our Saviour himself when speaking of divorce without any sufficient cause, and then marrying another woman, which is a species of polygamy.—Again, with respect to the alleged multiplicity of females in the eastern part of the world, it is by no means probable that the calculations of Mr Bruce or any other person can be admitted in this case. History mentions no such thing in any nation; and considering the vast destruction among the male part of the human species more than of the females by war and other accidents, we may safely say, that if *four* women children were born for every single male, there would in

Polygamy.

in ſuch countries be five or ſix grown up women for every man; a proportion which we may venture to affirm does not, nor ever did, exiſt anywhere in the world. That it was not ſo in former times we can only judge from the particular examples recorded in hiſtory, and theſe are but few. We read in the Greek hiſtory, indeed, of the *fifty* daughters of Danaus; but theſe were matched by as many *ſons* of another man. Job had only one wife, yet had *ſeven* ſons and but *three* daughters. Jacob had two wives, who bore *twelve* ſons, and only one daughter. Abraham had only one child by his firſt wife, and that was a ſon. By his ſecond wife Keturah he had ſix ſons; and conſidering his advanced age at the time he married her, it is by no means probable that he could have 24 daughters; nay, if, as Mr Bruce tells us, the women in the eaſtern countries bear children only for nine years, it was impoſſible ſhe could have ſo many. Gideon, who had many wives, had no fewer than ſeventy ſons by theſe wives, and even his concubine had a ſon; ſo that if all theſe women had produced according to Mr Bruce's proportion, of nearly three females to one male, he muſt have had almoſt 284 children; a better family than any of Mr Bruce's eaſtern acquaintances can probably boaſt of.

With regard to this ſubject, however, it muſt be obſerved, that the procreation of male or female children depends in ſome degree on the health and vigour of the parents. It is by no means improbable, therefore, that the eaſtern voluptuaries, whoſe conſtitutions are debilitated by their exceſſes, may have many more female than male children born to them. The women themſelves, by premature enjoyment, will alſo be inclined to produce females inſtead of males; but neither of theſe circumſtances can prove this to be an original law of nature. Something like this may be gathered from ſacred hiſtory. Gideon above-mentioned, who was a hardy and active warrior, had many ſons. The ſame was the caſe with David, who led an active and laborious life; while Solomon, who was a voluptuary, had only one ſon, notwithſtanding his multitude of wives.

The moſt barefaced defence of polygamy that has appeared in modern times is by the Rev. Mr Madan, who publiſhed a treatiſe, artfully vindicating, and ſtrongly recommending it, under the title of *Thelyphthora; or, A treatiſe on Female Ruin, in its Cauſes, Effects, Conſequences, Prevention, and Remedy*, &c. Marriage, according to this writer, ſimply and wholly conſiſts in the act of perſonal union, or *actus coitus*. Adultery, he ſays, is never uſed in the ſacred writings but to denote the defilement of a betrothed or married woman, and to this ſenſe he reſtricts the uſe of the term; ſo that a married man, in his opinion, is no adulterer, if his commerce with the ſex be confined to ſingle women, who are under no obligations by eſpouſals or marriage to other men: but, on the other hand, the woman who ſhould dare to have even but once an intrigue with any other man beſides her huſband, (let him have as many wives as Solomon), would, *ipſo facto*, be an adultereſs, and ought, together with her gallant, to be puniſhed with immediate death. This, he boldly ſays, is the law of God: and on this foundation he limits the privilege of polygamy to the man; in ſupport of which he refers to the polygamous connections of the patriarchs and ſaints of the Old Teſtament, and infers the lawfuluefs of their practice from the bleſſings which attended it, and the laws which were inſtituted to regulate and ſuperintend it. He contends for the lawfulneſs of Chriſtians having, like the ancient Jews, more wives than one; and labours much to reconcile the genius of the evangelical diſpenſation to an arrangement of this ſort. With this view he aſſerts, that there is not one text in the New Teſtament that even hints at the criminality of a polygamous connection; and he would infer from St Paul's direction, that biſhops and deacons ſhould have but one wife, that it was lawful for laymen to have more. Chriſt, he ſays, was not the giver of a new law; but the buſineſs of marriage, polygamy, &c. had been ſettled before his appearance in the world, by an authority which could not be revoked. Beſides, this writer not only thinks polygamy lawful in a religious, but advantageous in a civil, light, and highly politic in a domeſtic view.

In defence of his notion of marriage, which, he ſays, conſiſts in the union of man and woman as one body, the effects of which in the ſight of God no outward forms or ceremonies of man's invention can add to or detract from, he grounds his principal argument on the Hebrew words made uſe of in Gen. ii. 24. to expreſs the primitive inſtitution of marriage, viz. דבק באשתו, rendered by the LXX. προσκολληθησεται προς την γυναικα αυτου, which tranſlation is adopted by the evangeliſt (Mat, xix. 5.) with the omiſſion only of the ſuperfluous prepoſition (προς) after the verb. Our tranſlation, "ſhall cleave to his wife," doth not, he ſays, convey the idea of the Hebrew, which is literally, as Montanus renders the words, "ſhall be joined or cemented *in* his woman, and they ſhall become (*i. e.* by this union) one fleſh." But on this criticiſm it is well remarked, that both the Hebrew and Greek terms mean ſimply and literally attachment or adherence; and are evidently made uſe of in the ſacred writings to expreſs the whole ſcope of conjugal fidelity and duty, though he would reſtrain them to the groſſer part of it.

With reſpect to the Moſaic law, for which Mr Madan is a warm advocate, it was certainly a local and temporary inſtitution, adapted to the ends for which it was appointed, and admirably calculated, in its relation to marriage, to maintain and perpetuate the ſeparation of the Jewiſh people from the Gentiles. In attempting to depreciate the outward forms of marriage, this writer would make his readers believe, that becauſe none are explicitly deſcribed, therefore none exiſted; and conſequently that they are the ſuperfluous ordinances of human policy. But it is evident, from comparing Ruth iv. 10, 13. with Tobit vii. 13, 14. and from the caſe of Dinah, related Gen. xxxiv. that ſome forms were deemed eſſential to an honourable alliance by the patriarchs and ſaints under the Old Teſtament, excluſive of the carnal knowledge of each other's perſons. It is alſo evident in the caſe of the woman of Samaria, whoſe connection with a man not her huſband is mentioned in John iv. that ſomething beſides cohabitation is neceſſary to conſtitute marriage in the ſight of God.

Having ſtated his notion of marriage, he urges, in defence of polygamy, that, notwithſtanding the ſeventh commandment, it was allowed by God himſelf, who

Polygamy. who made laws for the regulation of it, wrought miracles in support of it by making the barren woman fruitful, and declared the iffue legitimate to all intents and purpofes. God's allowance of polygamy is argued from Exod. xxi. 10. and particularly from Deut. xxi, 15. which, he fays, amounts to a demonftration. This paffage, however, at the utmoft, only prefuppofes that the practice might have exiftence among fo hard-hearted and fickle a people as the Jews; and therefore wifely provides againft fome of its more unjuft and pernicious confequences, fuch as tended to affect the rights and privileges of heirfhip. Laws enacted to regulate it cannot be fairly urged in proof of its lawfulnefs on the author's own hypothefis; becaufe laws were alfo made to regulate divorce, which Mr Madan condemns as abfolutely unlawful, except in cafes of adultery. Befides, it is more probable that the "hated wife" had been difmiffed by a bill of divorcement, than that fhe was retained by her hufband: and moreover, it is not certain but that the two wives, fo far from living with the fame hufband at the fame time, might be dead; for the words may be rendered thus, "if there *fhould have been* to a man two wives, &c." The words expreffing the original inftitution of marriage, Gen. ii. 24. compared with Mat. xix. 4, 5, 8. afford infuperable objections againft Mr Madan's doctrine of polygamy.

If we appeal on this fubject, from the authority of Scripture to the writings of the earlieft fathers in the Chriftian church, there is not to be found the fainteft trace of any thing refembling a teftimony to the lawfulnefs of polygamy; on the contrary, many paffages occur, in which the practice of it is ftrongly and explicitly condemned.

Monthly Review, vol. 63. p. 338. See alfo vol. 69.

We fhall clofe this article with the words of an excellent anonymous writer already quoted, and to whofe critique on Mr Madan's work we are indebted for the above remarks: "In a word, when we reflect that the primitive inftitution of marriage limited it to one man and one woman; that this inftitution was adhered to by Noah and his fons, amidft the degeneracy of the age in which they lived, and in fpite of the examples of polygamy which the accurfed race of Cain had introduced; when we confider how very few (comparatively fpeaking) the examples of this practice were among the faithful; how much it brought its own punifhment with it; and how dubious and equivocal thofe paffages are in which it appears to have the fanction of divine approbation; when to thefe reflections we add another, refpecting the limited views and temporary nature of the more ancient difpenfations and inftitutions of religion—how often the imperfections and even vices of the patriarchs and people of God, in old time, are recorded, without any exprefs notification of their criminality—how much is faid to be commanded, which our reverence for the holinefs of God and his law will only fuffer us to fuppofe, were, for wife ends, permitted—how frequently the meffengers of God adapted themfelves to the genius of the people to whom they were fent, and the circumftances of the times in which they lived:—above all, when we confider the purity, equity, and benevolence of the Chriftian law; the explicit declarations of our Lord, and his apoftle St Paul, refpecting the inftitution of marriage, its defign and limitation;—when we reflect, too, on the teftimony of the moft ancient fathers, who could not poffibly be ignorant of the general and common practice of the apoftolic church; and, finally, when to thefe confiderations we add thofe which are founded on juftice to the female fex, and all the regulations of domeftic economy and national policy—we muft wholly condemn the revival of polygamy; and thus bear our honeft teftimony againft the leading defign of this dangerous and ill-advifed publication."

We would advife our readers to read the whole criticifms on Madan's book in the Monthly Review, together with their account of the feveral anfwers to it. The reverend author of the Thelyphthora has there met with a moft able antagonift, who traces him through all his deceitful windings, and expofes the futility and falfehood of his arguments with fingular ability. See *Monthly Review*, vol. lxiii. p. 273, &c.; fee alfo *Paley's Moral Philofophy*, 4to. p. 262.

POLYGARS, are natives of Hindoftan. They inhabit almoft impenetrable woods, and are under the abfolute direction of their own chieftains. In time of peace they are profeffionally robbers, but in times of war are the guardians of the country. The general name of thefe people is *Polygar*. Their original inftitution, for they live in diftinct clans, is not very well underftood. It probably took its rife from the municipal regulations relative to the deftruction of tygers and other ferocious beafts. Certain tracts of woodland were indifputably allotted as rewards to thofe who fhould flay a certain number of thofe animals; and thofe lands approximating, probably laid the foundation of the feveral confederacies of Polygars.

"The Pollams, or woods, from which is derived the word *Polygar*, lying in profufion through all the fouthern parts of Hindoftan, the ravages committed in the open countries by thefe adventurous clans, are both frequent and deftructive. Cattle and grain are the conftant booty of the Polygars. They not unfrequently even defpoil travellers of their property, and fometimes murder, if they meet with oppofition: yet thefe very Polygars are the hands into which the aged and infirm, the wives, children, and treafure, of both Hindoos and others are entrufted, when the circumjacent country unfortunately happens to be the feat of war. The protection they afford is paid for; but the price is inconfiderable, when the helplefs fituation of thofe who fly to them for fhelter is confidered, and efpecially when their own very peculiar character is properly attended to. The native governments of Hindoftan are under the neceffity of tolerating this honourable banditti. Many of them are fo formidable as to be able to bring 15,000 and 20,000 men into the field.

"The Hindoo code of laws, in fpeaking of robberies, hath this remarkable claufe, 'The mode of fhares amongft robbers fhall be this:—If any thief or thieves, by the command of the magiftrate, and with his affiftance, have committed depredations upon, and brought away any booty from, another province, the magiftrate fhall receive a fhare of one fixth part of the whole. If they received no command or affiftance from the magiftrate, they fhall give the magiftrate in that cafe one tenth part for his fhare, and of the remainder their chief fhall receive four fhares; and whofoever

 among

among them is perfect master of his occupation, shall receive three shares: also, whichever of them is remarkably strong and stout, shall receive two shares, and the rest shall receive each one share.' Here, then, we see not only a sanction, but even an inducement, to fraudulent practices.—Another singular inconsistency among a people who, in many periods of their history, have been proverbial for innocency of manners, and for uncommon honesty in their conduct towards travellers and strangers.

"At the first sight, it would appear that the toleration of the Polygars, owing to their great numbers, and to the security of their fortresses, which are in general impenetrable but to Polygars; that the government licence, in this manner given to them, to live on the spoils of the industrious—might have originally occasioned the formal division, and encouragement to perseverance, which we have just quoted: but the cause I should rather suppose to lie in the nature of certain governments, than to have arisen from any accidental circumstance afterwards; and I am the more inclined to this opinion, from the situation of the northern parts of Hindostan, which are, and always have been, uninfested by these freebooters.

"The dominion of the East was, in former days, most probably divided and subdivided into all the various branches of the feodal system. The vestiges of it remain to this hour: rajahs and zemindars are nothing more than chieftains of a certain degree of consequence in the empire. If, then, experience has shown, in other parts of the world, that clans have always been observed to commit the most pernicious acts of depredation and hostility on each other, and that the paramount lord has seldom been able effectually to crush so general and so complicated a scene of mischief—may we not reasonably venture to suppose, that the Hindoo legislature passed this ordinance for the suppression of such provincial warfare, and for the wholesome purpose of drawing the people, by unalarming degrees, more immediately under the controul of the one sovereign authority? The conclusion, I own, appears to me satisfactory. Moreover, Polygars cannot but be of modern growth; for the law relative to thefts is antecedent to the mention of Polygars in history." Sullivan's *Philosophical Rhapsodies.*

POLYGLOTT, among divines and critics, chiefly denotes a Bible printed in several languages. See Bible and Printing.

POLYGLOTTUS, in ornithology. See Turdus.

POLYGNOTUS, a famous painter of Thasos, flourished about 422 years before the Christian era, and was the son and scholar of Aglaophon. He adorned one of the public porticoes of Athens with his paintings, in which he had represented the most striking events of the Trojan war. The Athenians were so pleased with him, that they offered to reward his labours with whatever he pleased to accept; but he declined the offer; and the Amphictyonic council, which was composed of the representatives of the principal cities of Greece, ordered that Polygnotus should be maintained at the public expence wherever he went.

Of the talents of Polygnotus much honourable mention is made by many of the best authors of antiquity, as Aristotle and Plutarch, Dionysius Halicarnassensis, &c. Pausanias speaks of his pictures of the events of the Trojan war, and, in his Tenth Book, introduces a very long description of other pictures by the same artist, painted also from Homer in the temple at Delphos. The passage, however, gives but a confused and imperfect idea of the painter's performance. How much the art is indebted to this ancient master, what grace and softness he gave to the human countenance, what embellishments he added to the female figure and dress, are much more happily described by Pliny. "Primus mulieres lucida veste pinxit, capita earum mitris versicoloribus operuit, plurimumque picturæ primus contulit: siquidem instituit os adaperire, dentes ostendere, vultum ab antiquo rigore variare."—The same author likewise bears honourable testimony to the liberal spirit of this great artist, who refused any reward for his ingenious labours in the portico.—"Porticum gratuito, cum partem ejus Mycon mercede pingeret." Plin. *lib.* 35. *cap.* 8.

POLYGON, in geometry, a figure with many sides, or whose perimeter consists of more than four sides at least; such are the pentagon, hexagon, heptagon, &c.

POLYGONUM, Knot-grass: A genus of the trigynia order, belonging to the octandria class of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. There is no calyx; the corolla is quinquepartite, and calycine, or serving instead of a calyx; there is one angulated seed. There are 27 species; but the most remarkable are, 1. The bistorta, bistort, or greater snakeweed, hath a thick oblique intorted root, blackish without, and red within; a simple, round, slender stem, near two feet high; oval leaves, having decurrent foot-stalks, and the stalk terminated by thick short spikes of whitish-red flowers. 2. The viviparum, or smaller bistort, hath a thickish root, a simple slender stem half a foot high, spear-shaped leaves, and the stalks and branches terminated by long spikes of whitish-red flowers. Both these perennials flower in May and June, succeeded by ripe seeds in August. They grow wild in England, &c. the first in moist, the other in mountainous, situations. 3. Oriental polygonum, commonly called *persicaria*, hath fibrous roots; an upright, robust, strong, jointed stem, rising eight or ten feet high, dividing at top into several branches; very large oval-lanceolate alternate leaves, on broad footstalks half surrounding the stem; and all the branches terminated by long, slender, hanging spikes of reddish-purple heptandrous and digynious flowers, from July till October. 4. Fagopyrum, buckwheat, or brank, rises with an upright, smooth, branchy stem, from about a foot and a half to a yard high, heart-shaped sagittated leaves, and the branches terminated by clusters of whitish flowers, succeeded by large angular seeds; excellent for feeding pigeons and most sorts of poultry.

All these plants are hardy, and succeed in almost any soil and situation; the two first are perennial in root; and the third and fourth are annual, wholly decay at the end of summer, or early in winter. The first two sorts are retained in some curious gardens for variety; but their chief merit is for medical purposes; they are powerful astringents, and are used both internally and externally; esteemed very efficacious in hæmorrhagies and other fluxes; and good to heal sore mouths. The third sort, Oriental polygonum, or persicaria, is a most elegant

Polygonum || Polyhedron.

elegant annual for the embellishment of pleasure-ground; assuming a majestic tree-like growth by its erect luxuriant stem, and branchy head; which being garnished with noble large foliage, and numerous pendulous spikes of flowers, in constant succession three or four months, exhibits a very ornamental appearance from June or July until October, and is so easy of culture, that from its scattered seeds in autumn, young plants rise spontaneously in abundance the ensuing spring, and shoot up so rapidly as to attain six or eight feet in height by July, when they generally begin flowering, and continue till attacked by the frost, when they totally perish; so that a fresh supply must be raised from seed annually. The fourth sort (buck-wheat) is a sort of corn, and is frequently cultivated both by way of fodder, cutting its stalks while young and green to feed cattle, and for its grain to feed pigeons, poultry, hogs, &c. It flourishes in any soil and situation, but generally thrives best in a light dry earth; and the driest seasons seldom retard its growth. The first and second sorts are easily propagated in plenty, by parting the roots in autumn. The third sort, Oriental polygonum, being annual, is always propagated from seed annually, either in the full ground, or by means of hot-beds.

Uses. The root of a kind of bistort, according to Gmelin, is used in Siberia for ordinary food. This species is by Haller called *bistorta foliis ad oram nervosis*, and by some other botanists *bistorta montana minor*. The natives call it *mouka;* and so indolent are they, that, to save themselves the trouble of digging it out of the earth, they go in spring and pillage the holes of the mountain rats, which they find filled with these roots. In our country, bistort is used as a medicine. All the parts of bistort have a rough austere taste, particularly the root, which is one of the strongest of the vegetable astringents. It is employed in all kinds of immoderate hæmorrhagies and other fluxes, both internally and externally, where astringency is the only indication. It is certainly a very powerful styptic, and is to be looked on simply as such; the sudorific, antipestilential, and other like virtues ascribed to it, it has no other claim to than in consequence of its astringency, and of the antiseptic power which it has in common with other vegetable styptics. The largest dose of the root in powder is a single dram.

POLYGRAPHY, Polygraphia, or *Polygraphice*, the art of writing in various unusual manners or ciphers; as also of deciphering the same. The word is formed from the Greek, πολυ, *multum*, and γραφη, *scriptura*, "writing."

The ancients seem to have been very little acquainted with this art; nor is there any mark of their having gone beyond the Lacedæmonian scytala. Trithemius, Porta, Vigenere, and father Niceron, have written on the subject of polygraphy or ciphers. See Cipher.

POLYHYMNIA, in the pagan mythology, one of the nine muses, thus named from the Greek words Πολυς "much," and μνεια "memory." She presided over history, or rather rhetoric; and is represented with a crown of pearls and a white robe; her right hand in action as if haranguing, and holding in her left a caduceus or sceptre to show her power.

POLYHEDRON, in geometry, denotes a body or solid comprehended under many sides or planes.

Polyhedron, in optics, is a multiplying glass or lens, consisting of several plane surfaces disposed into a convex form. See Optics, n° 256.

POLYMATHY, denotes the knowledge of many arts and sciences. The word is derived from the Greek, πολυ, *multum*, and μαθανω, *disco*.

POLYMNESTOR, was a king of the Thracian Chersonesus. He married Ilione, Priam's eldest daughter; and for the sake of the treasure with which he was entrusted by Priam during the siege of Troy, he murdered Polydorus, (see Polydorus). The fleet in which the victorious Greeks returned, together with their Trojan captives, among whom was Hecuba, stopped on the coasts of Thrace, where one of the female captives discovered on the shore the body of Polydorus, whom Polymnestor had thrown into the sea. The dreadful intelligence was immediately communicated to Hecuba his mother, who recollecting the frightful dreams she had the preceding night, did not doubt but Polymnestor was the cruel assassin. Resolved to revenge her son's death, she immediately called out Polymnestor, as if to impart to him something of importance. He was drawn into the snare; and no sooner was he introduced into the apartment of the Trojan princess, than the female captives rushing upon him, put out his eyes with their pins, while Hecuba murdered his two children, who had accompanied him. Euripides informs us, that the Greeks condemned Polymnestor to be banished into a distant island for his perfidy. Hyginus, however, relates the whole differently, and tells us, that when Polydorus was sent to Thrace, Ilione his sister took him instead of her son Deiphilus, who was of the same age, being fearful of her husband's cruelty. The monarch, unacquainted with the imposition, looked upon Polydorus as his own son, and treated Deiphilus as her brother. After the destruction of Troy, the conquerors wished the house and family of Priam to be extirpated, and therefore offered Electra the daughter of Agamemnon to Polymnestor, if he would destroy Ilione and Polydorus. He accepted the offer, and immediately dispatched his own son Deiphilus, whom he took for Polydorus. Polydorus, who passed as the son of Polymnestor, consulted the oracle after the murder of Deiphilus, and being informed that his father was dead, his mother a captive in the hands of the Greeks, and his country in ruins, he communicated the answer to Ilione, whom he had always regarded as his mother. She told him the measures she had pursued to save his life, upon which he avenged the perfidy of Polymnestor by putting out his eyes.

POLYMNIA, in botany: A genus of the polygamia necessaria order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, *Compositæ*. The receptacle is paleaceous; there is no pappus; the exterior calyx is tetraphyllous, or pentaphyllous; the interior decaphyllous, and composed of concave leafets.

POLYNICES, the son of Œdipus by his mother Jocasta. See Jocasta, Œdipus, and Eteocles.

POLYPE. See Polypus.

POLYPETALOUS, among botanists, an epithet applied to such flowers as consist of several petals or flower-leaves.

POLYPHEMUS (fab. hist.), a celebrated Cyclops, and king of all the Cyclops in Sicily, was the son of Neptune and Thoosa the daughter of Phorcys. He is said to have been a monster of great strength, very tall, and

and with one eye in the middle of the forehead. He eat human flesh, and kept his flocks on the coasts of Sicily, when Ulysses, at his return from the Trojan war, was driven there. Ulysses, together with 12 of his companions, visited the coast, and with them was seized by the Cyclops, who confined them in his cave, and daily devoured two of them. Ulysses would have shared the fate of the rest, had he not intoxicated the Cyclops, and put out his eye with a firebrand when he was asleep. Polyphemus was awakened by the sudden pain, and stopped the entrance of his cave; but Ulysses escaped, by creeping between the legs of the rams of the Cyclops, as they were led out to feed on the mountains. Polyphemus became enamoured of Galatæa; but his addresses were disregarded, and the nymph shunned his presence. The Cyclops was still more earnest; and when he saw Galatæa surrender herself to the pleasures of Acis, he crushed his rival with a piece of a broken rock.

POLYPODIUM, in botany; a genus of the order of filices, belonging to the cryptogamia class of plants. The fructifications are in roundish points, scattered over the inferior disc of the frons or leaf.—There are 65 species, of which the most remarkable is the filix mas, or common male fern. This grows in great plenty throughout Britain in woods and stony uncultivated soils. The greatest part of the root lies horizontally, and has a great number of appendages placed close to each other in a vertical direction, while a number of small fibres strike downwards. The leaves are a cubit high, and grow in circular tufts. They are at first alternately pinnate, the pinnæ increasing in size from the base towards the middle, and afterwards gradually decreasing upwards to the summit of the leaf. These pinnæ are again pinnatifid, or subdivided almost to the nerve into obtuse parallel lobes, crenated on the edges. The stalks are covered with brown filmy scales. The fructifications are kidney-shaped, and covered with a permanent scaly shield or involucrum. The capsules are of a pale brown, surrounded with a saffron-coloured elastic ring.

This fern has nearly the same qualities, and is used for most of the same intentions, as the pteris aquilina. They are both burnt together for the sake of their ashes, which are purchased by the soap and glass-makers. In the island of Jura are exported annually 150 l. worth of these ashes.

Gunner relates, in his *Flor. Noveg.* that the young curled leaves, at their first appearance out of the ground, are by some boiled and eaten like asparagus; and that the poorer Norwegians cut off those succulent laminæ, like the nails of the finger at the crown of the root, which are the bases of the future stalks, and brew them into beer, adding thereto a third portion of malt, and in times of great scarcity mix the same in their bread. The same author adds, that this fern cut green, and dried in the open air, affords not only an excellent litter for cattle, but, if infused in hot water, becomes no contemptible fodder to goats, sheep, and other cattle, which will readily eat and sometimes grow fat upon it: a circumstance well worth the attention of the inhabitants of the Highlands and Hebrides, as great numbers of their cattle, in hard winters, frequently perish for want of food.

But the anthelmintic quality of the root of the male fern is that for which it is chiefly to be valued, and of which an account is given under the article MEDICINE, p. 343. col. 2.

Polypremum, Polypus.

The polypodium oreopteris is only remarkable because it has been confounded by most of the English botanists with the species which we have now described, and the polypodium thelypteris. It has a large scaly root, wrapped and tied together with small strong fibres, not to be separated without difficulty.—The fructifications are on the margins both when young and old, and never run into one another: the lobes are oval and plain. It is four times as large as the thelypteris, and grows in dry woods, moors, or hills, and very seldom near water; all which characters are widely different from those of the species with which it has been confounded. It is to be found both in England and Scotland, in the latter place very plentifully. See *Linnæan Transactions*, vol. 1. p. 181.

POLYPREMUM, in botany: A genus of the monogynia order, belonging to the tetrandria class of plants; and in the natural method ranking under the 22d order, *Caryophillei*. The calyx is tetraphyllous; the corolla quadrifid and rotaceous, with its lobes obcordate; the capsule compressed, emarginated, and bilocular.

POLYPUS, a species of fresh-water insects, belonging to the genus of hydra, of the order of zoophytes, and class of vermes. (See ANIMALCULE, n° 24, &c.) The name of *hydra* was given them by Linnæus on account of the property they have of reproducing themselves when cut in pieces, every part soon becoming a perfect animal. Dr Hill called them *biota*, on account of the strong principle of life with which every part of them is endowed.

These animals were first discovered by Leeuwenhoek, who gave some account of them in the Philosophical Transactions for 1703; but their wonderful properties were not thoroughly known till the year 1740, when Mr Trembley began to investigate them. Previous to his discoveries, indeed, Leibnitz and Boerhaave, by reasonings *à priori*, had concluded that animals might be found which would propagate by slips like plants; and their conjectures were soon verified by the observations of the gentleman above-mentioned. At first, however, Mr Trembley was uncertain whether he should reckon these creatures animals or plants; and while thus uncertain, he wrote a letter on the subject to Mr Bonnet in January 1741; but in March the same year he had satisfied himself that they were real animals. The surprise of Mr Trembley, and of others, on discovering the true nature of these animals, was very great. When Mr Reaumur saw for the first time two polypes formed from one which he had divided into two parts, he could hardly believe his own eyes; and even after having repeated the operation an hundred times, he said that the sight was by no means familiar to him. On the 18th of July 1741, M. Buffon wrote to Martin Folkes, Esq; president of the Royal Society, acquainting him with "the discovery of a small insect called a *polypus*, which is found about the common duck-weed; and which, being cut in two, puts forth from the upper part a tail, and from the lower end a head, so as to become two animals instead of one. If it be cut into three parts, the middlemost also puts out from one end a head, and from the other a tail, so as to become three distinct animals, all living like the first, and performing the various offices of their species."

Polypus.

species."—In September the same year, a letter was communicated from C. Bentink, Esq; at the Hague, describing the insects discovered by Mr Trembley, adding, that he himself had seen them; and in November that year, a letter was read before the Society from Gronovius at Leyden, giving an account of a water-insect, which, says he, if cut into five or six pieces, in a few hours there will be as many animals exactly similar to their parent. These accounts, however, were all deemed so extraordinary, that they were not credited, until professors Albinus and Muschenbroeck provided themselves with them, and found every thing related concerning them to be exactly true. In March 1742, Mr Folkes gave an account of them to the Royal Society, from some observations made on several polypes which Mr Trembley had sent from Holland. They were soon after found in England, and the observations made upon them were published by several persons; so that no doubt remained concerning the reality of what had been related concerning them.

The general character of the polype is, that it fixes itself by its base; is gelatinous, linear, naked, contractile; and can change its place. The mouth, which is placed at one end, is surrounded by hair-like feelers. The young ones grow out from its sides; but in autumn it produces eggs from its sides. There are six varieties.

1. The *viridis*, or green polype, has commonly ten short arms.

2. The *fusca* has frequently eight arms several times longer than the body.

3. The *grisea* is of a yellowish colour, small towards the bottom, and has long arms, generally about seven in number.

4. The *pallens* has generally about six arms of a moderate length.

5. The *hydatula* has a vesicular body, and four obsolete arms. It is found in the abdomen of sheep, swine, &c.

6. The *stentorea* has been called the *tunnel-shaped*, and has a mouth surrounded with a row of hairs.

7. The *socialis* is bearded, thick, and wrinkled.

The three first species are those on which the greatest number of experiments have been made; and their shapes are so various, that it is by no means easy to describe them. They are generally found in ditches. Whoever has carefully examined these when the sun is very powerful, will find many little transparent lumps of the appearance of a jelly, and size of a pea, and flatted upon one side. The same kind of substances are likewise to be met with on the under side of the leaves of plants which grow in such places. These are the polypes in a quiescent state, and apparently inanimate. They are generally fixed by one end to some solid substance, with a large opening, which is the mouth, at the other; having several arms fixed round it, projecting as rays from the centre. They are slender, pellucid, and formed of a tender substance like the horns of a snail, and capable of contracting themselves into a very small compass, or of extending to a considerable length. The arms are capable of the same contraction and expansion as the body; and with these they lay hold of minute worms and other insects, bringing them to the mouth and swallowing them; the indigestible parts are again thrown out by the mouth.

The green polype was that first discovered by Mr Trembley; and the first appearances of spontaneous motion were perceived in its arms, which it can contract, extend, and twist about in various directions. On the first appearance of danger they contract to such a degree that they appear little bigger than a grain of sand, of a fine green colour, the arms disappearing entirely. Soon after he found the grisea, and afterwards the fusca.

The bodies of the viridis and grisea diminish almost insensibly from the anterior to the posterior extremity; but the fusca is for the most part of an equal size for two-thirds of its length from the anterior to the posterior extremity, from which it becomes abruptly smaller, and then continues of a regular size to the end. These three kinds have at least six, and at most 12 or 13 arms, though sometimes the grisea is met with having 18 arms. They can contract themselves till their bodies do not exceed one-tenth of an inch in length, and they can stop at any intermediate degree of contraction or extension. They are of various sizes, from half an inch to an inch and an half long; their arms are seldom longer than their bodies, though some have them an inch, and some even eight inches, long. The thickness of their bodies decreases as they extend themselves, and *vice versa*; and they may be made to contract themselves either by agitating the water in which they are contained, or by touching the animals themselves. When taken out of the water, they all contract so much that they appear only like a little lump of jelly. The arms have the same power of contraction or expansion that the body has; and they can contract or expand one arm, or any number of arms, independent of the rest; and they can likewise bend their bodies or arms in all possible directions. They can also dilate or contract their bodies in various places, and sometimes appear thick set with folds, which, when carelessly viewed, appear like rings. Their progressive motion is performed by that power which they have of contracting and dilating their bodies. When about to move, they bend down their head and arms, lay hold by means of them on some other substance to which they design to fasten themselves; then they loosen their tail, and draw it towards the head; then either fix it in that place, or stretching forward their head as before, repeat the same operation. They ascend or descend at pleasure in this manner upon aquatic plants, or upon the sides of the vessel in which they are kept; they sometimes hang by the tail from the surface of the water, or sometimes by one of the arms; and they can walk with ease upon the surface of the water. On examining the tail with a microscope, a small part of it will be found to be dry above the surface of the water, and as it were in a little concave space, of which the tail forms the bottom; so that it seems to be suspended on the surface of the water on the same principle that a small pin or needle is made to swim. When a polype, therefore, means to pass from the sides of the glass to the surface of the water, it has only to put that part out of the water by which it is to be supported, and to give it time to dry, which it always does upon these occasions; and they attach themselves so firmly by the tail to aquatic plants, stones, &c. that they cannot be easily disengaged: they often further strengthen these attachments by means

Polypus. means of one or two of their arms, which ſerve as a kind of anchors for fixing them to the adjacent ſubſtances.

The ſtomach of the polype is a kind of bag or gut into which the mouth opens, and goes from the head to the tail. This, in a ſtrong light, is viſible to the naked eye, eſpecially if the animal be placed between the eye and a candle; for theſe animals are quite tranſparent whatever their colour may be. The ſtomach, however, appears to more advantage through a powerful magnifier. Mr Trembley, by cutting one of theſe animals tranſverſely into three parts, ſatisfied himſelf that they were perforated throughout. Each piece immediately contracted itſelf, and the perforation was very viſible through a microſcope. The ſkin which incloſes the ſtomach is that of the polype itſelf; ſo that the whole animal, properly ſpeaking, conſiſts only of one ſkin, in the form of a tube, and open at both ends. No veſſels of any kind are to be diſtinguiſhed.

The mouth is ſituated at the anterior end in the middle between the ſhooting forth of the arms, and aſſumes different appearances according to circumſtances; being ſometimes lengthened out in the form of a nipple, at others appearing truncated; ſometimes the aperture is quite cloſed, at others there is a hollow; though at all times a ſmall aperture may be diſcovered by a powerful magnifier.

The ſkin of a polype, when examined with a microſcope, appears like ſhagreen, or as if covered with little grains, more or leſs ſeparated from each other, according to the degree of contraction of the body. If the lips of a polype be cut tranſverſely, and placed ſo that the cut part of the ſkin may lie directly before the microſcope, the ſkin throughout its whole thickneſs will be found to conſiſt of an infinite number of grains, and the interior part is found to be more ſhagreened than the exterior one; but they are not ſtrongly united to each other, and may be ſeparated without much trouble. They even ſeparate of themſelves, though in no great numbers, in the moſt healthy animals of this kind; for where they are obſerved to ſeparate in large quantities, it is a ſymptom of a very dangerous diſorder. In the progreſs of this diſorder, the ſurface of the polype becomes gradually more and more rough and unequal, and no longer well defined or terminated as before. The grains fall off on all ſides; the body and arms contract and dilate, and aſſume a white ſhining colour; and at laſt the whole diſſolves into an heap of grains, which is more particularly obſerved in the green polype. By a careful examination we find, that the ſkin of the polype is entirely compoſed of grains, cemented by means of a kind of gummy ſubſtance; but it is to the grains entirely that the polype owes its colour. The ſtructure of the arms is analogous to that of the body; and they appear ſhagreened when examined by the microſcope, whether they be in a ſtate of contraction or extenſion; but if very much contracted, they appear more ſhagreened than the body, though almoſt quite ſmooth when in their utmoſt ſtate of extenſion. In the green polype the appearance of the arm is continually varying; and theſe variatiations are more ſenſible towards the extremity of the arm than at its origin, but more ſcattered in the parts further on. The extremity is often terminated by a knob, the hairs of which cannot be obſerved without a very powerful magnifier. They have a remarkable inclination of turning towards the light; ſo that if that part of the glaſs on which they are be turned from the light, they will quickly remove to the other.

Polypus. That ſpecies named the *fuſca* has the longeſt arms, and makes uſe of the moſt curious manœuvres to ſeize its prey. They are beſt viewed in a glaſs ſeven or eight inches deep, when their arms commonly hang down to the bottom. When this, or any other kind, is hungry, it ſpreads its arms in a kind of circle to a conſiderable extent, incloſing in this, as in a net, every inſect which has the misfortune to come within the circumference. (See ANIMALCULE, n° 27.) While the animal is contracted by ſeizing its prey, the arms are obſerved to ſwell like the muſcles of the human body when in action. Though no appearance of eyes can be obſerved in the polype, they certainly have ſome knowledge of the approach of their prey, and ſhow the greateſt attention to it as ſoon as it comes near them. It ſeizes a worm the moment it is touched by one of the arms; and in conveying it to the mouth, it frequently twiſts the arm into a ſpiral like a corkſcrew; by which means the inſect is brought to the mouth in a much ſhorter time than otherwiſe it would be; and ſo ſoon are the inſects on which the polypes feed killed by them, that M. Fontana thinks they muſt contain the moſt powerful kind of poiſon; for the lips ſcarce touch the animal when it expires, though there cannot be any wound perceived on it when dead. The worm, when ſwallowed, appears ſometimes ſingle, ſometimes double, according to circumſtances. When full, the polype contracts itſelf, hangs down as in a kind of ſtupor, but extends again in proportion as the food is digeſted and the excrementitious part is diſcharged. The bodies of the inſects, when ſwallowed, are firſt macerated in the ſtomach, then reduced into fragments, and driven backward and forward from one end of the ſtomach to the other, and even into the arms, however fine they may be; whence it appears that the arms, as well as the other parts of this remarkable creature, are a kind of hollow guts or ſtomachs. In order to obſerve this motion, it is beſt to feed the polypes with ſuch food as will give a lively colour; ſuch, for inſtance, as thoſe worms which are furniſhed with a red juice. Some bits of a ſmall black ſnail being given to a polype, the ſubſtance of the ſkin was ſoon diſſolved into a pulp conſiſting of ſmall black fragments; and on examining the polype with a microſcope, it was found that the particles were driven about in the ſtomach, and that they paſſed into the arms, from thence back into the ſtomach, then to the tail; from whence they paſſed again into the arms, and ſo on. The grains of which the body of the polype conſiſt take their colour from the food with which it is nouriſhed, and become red or black as the food happens to afford the one colour or the other. They are likewiſe more or leſs tinged with theſe colours in proportion to the ſtrength of the nutritive juices; and it is obſervable that they loſe their colour if fed with aliments of a colour different from themſelves. They feed on moſt inſects found in freſh water; and will alſo be ſupported with worms, the larvæ of gnats, &c. and even with ſnails, large aquatic inſects, and fiſh or fleſh, if cut into ſmall bits. Sometimes two polypes lay hold of the ſame worm, and each begins

Polypus.

begins to ſwallow its own end till their mouths meet and the worm breaks. But ſhould this happen not to be the caſe, the one polype will ſometimes devour the other along with its portion. It appears, however, that the ſtomach of one polype is not fitted for diſſolving the ſubſtance of another; for the one which is ſwallowed always gets clear again after being impriſoned for an hour or two.

The manner in which the polypes generate is moſt perceptible in the griſea and fuſca, as being conſiderably larger than the viridis. If we examine one of them in ſummer, when the animals are moſt active, and prepared for propagation, ſome ſmall tubercles will be found proceeding from its ſides, which conſtantly increaſe in bulk, until at laſt in two or three days they aſſume the figure of ſmall polypes. When they firſt begin to ſhoot, the excreſcence becomes pointed, aſſuming a conical figure, and deeper colour than the reſt of the body. In a ſhort time it becomes truncated, and then cylindrical, after which the arms begin to ſhoot from the anterior end. The tail adheres to the body of the parent-animal, but gradually grows ſmaller, until at laſt it adheres only by a point, and is then ready to be ſeparated. When this is the caſe, both the mother and young ones fix themſelves to the ſides of the glaſs, and are ſeparated from each other by a ſudden jerk. The time requiſite for the formation of the young ones is very different, according to the warmth of the weather and the nature of the food eaten by the mother. Sometimes they are fully formed, and ready to drop off, in 24 hours; in other caſes, when the weather is cold, 15 days have been requiſite for bringing them to perfection.

It is remarkable, that there is a reciprocal communication of food betwixt the young and old before they be ſeparated. The young ones, as ſoon as they are furniſhed with arms, catch prey for themſelves, and communicate the digeſted food to the old ones, who on the other hand do the ſame to the young ones. This was fully verified by the following experiment: One of the large polypes of the *fuſca* kind being placed on a ſlip of paper in a little water, the middle of the body of a young one growing out from it was cut open; when the ſuperior part of that end which remained fixed to the parent was found to be open alſo. By cutting over the parent polype on each ſide of the ſhoot, a ſhort cylinder was obtained, open at both ends; which being viewed through a microſcope, the light was obſerved to come through the young one into the ſtomach of the old one. On cutting open the cylindrical portion lengthwiſe, not only the hole of communication was obſerved, but one might ſee through the end of the young one alſo. On changing the ſituation of the two pieces, the light was ſeen through the hole of communication. This may be ſeen between the parent polype and its young ones after feeding them; for, after the parents have eaten, the bodies of the young ones ſwell as if they themſelves had been eating.

The polypes produce young ones indiſcriminately from all parts of their bodies, and five or ſix young ones have frequently been produced at once; nay, Mr Trembley has obſerved nine or ten produced at the ſame time.

Nothing like copulation among theſe creatures was ever obſerved by Mr Trembley, though for two years he had thouſands of them under his inſpection. To be more certain on this ſubject, he took two young ones the moment they came from their parent, and placed them in ſeparate glaſſes. Both of them multiplied, not only themſelves, but alſo their offspring, which were ſeparated and watched in the ſame manner to the ſeventh generation; they have even the ſame power of generation while adhering to their parent. In this ſtate the parent, with its children and grandchildren, exhibits a ſingular appearance, looking like a ſhrub thick ſet with branches. Thus ſeveral generations ſometimes are attached to one another, and all of them to one parent. Mr Adams gives a figure of one polype with *nineteen* young ones hanging at it; the whole group being about an inch broad, and an inch and an half in length: the old polype eat about twelve monoculi per day, and the young ones about 20 among them.

When a polype is cut tranſverſely or longitudinally into two or three parts, each part in a ſhort time becomes a perfect animal; and ſo great is this prolific power, that a new animal will be produced even from a ſmall portion of the ſkin of the old one. If the young ones be mutilated while they grow upon the parent, the parts ſo cut off will be reproduced, and the ſame property belongs to the parent. A truncated portion will ſend forth young ones before it has acquired a new head and tail of its own, and ſometimes the head of the young one ſupplies the place of that which ſhould have grown out of the old one. If we ſlit a polype longitudinally through the head to the middle of the body, we ſhall have one formed with two heads; and by ſlitting theſe again in the ſame manner we may form one with as many heads as we pleaſe.

A ſtill more ſurpriſing property of theſe animals is, that they may be grafted together. If the truncated portions of a polype be placed end to end, and gently puſhed together, they will unite into a ſingle one. The two portions are firſt joined together by a ſlender neck, which gradually fills up and diſappears, the food paſſing from the one part into the other; and thus we may form polypes not only from portions of the ſame, but of different animals; we may fix the head of one to the body of another, and the compound animal will grow, eat, and multiply, as if it had never been divided. By puſhing the body of one into the mouth of another, ſo far that their heads may be brought into contact, and kept there for ſome time, they will at laſt unite into one animal, only having double the number of arms which it would otherwiſe have had. The *hydra fuſca* may be turned inſide out like a glove, at the ſame time that it continues to live and act as before. The lining of the ſtomach now forms the outer ſkin, and the former epidermis conſtitutes the lining of the ſtomach. If previous to this operation the polype have young ones attached to it, ſuch as are but newly beginning to vegetate turn themſelves inſide out, while the larger ones continue to increaſe in ſize till they reach beyond the mouth of the parent, and are then ſeparated in the uſual manner from the body. When thus turned the polype combines itſelf in many different ways. The fore part frequently cloſes and becomes a ſupernumerary tail. The animal, which was at firſt ſtraight, now bends itſelf, ſo that the two tails reſemble the legs of a pair of compaſſes, which it can open and ſhut. The old mouth is placed as it were at the joint of the compaſſes, but loſes its power of action; to ſupply which, a new one is formed

Polypus. formed in its neighbourhood; and in a little time there is a new fpecies of hydra formed with feveral mouths.

The fides of a polype, which has been cut through in a longitudinal direction, begin to roll themfelves up, commonly from one of the extremities, with the outfide of the fkin inwards; but in a little time they unroll themfelves, and the two cut edges join together, fometimes beginning at one extremity, and fometimes approaching throughout their whole length. As foon as the edges join, they unite fo clofely that no fcar can be perceived. If a polype be partly turned back, the open part clofes, and new mouths are formed in different places. Every portion of a polype is capable of devouring infects almoft as foon as it is cut off: and the voracity of the whole genus is aftonifhing; for Mr Adams obferves, that moft of the infects on which they feed bear the fame proportion to the mouth of a polype that an apple of the fize of a man's head bears to his mouth.

The *hydra pallens* is very rarely met with, and is defcribed only by M. Roefel. It is of a pale yellow colour, growing gradually fmaller from the bottom; the tail is round or knobbed; the arms are about the length of the body, of a white colour, generally feven in number, and are apparently compofed of a chain of globules. The young are brought forth from all parts of its body.

The *hydratula* is mentioned by many medical writers. Dr Tyfon, in diffecting an antelope, found feveral hydatides or films, about the fize of a pigeon's egg, filled with water, and of an oval form, faftened to the omentum; and fome in the pelvis between the bladder of urine and rectum. He fufpected them to be animals for the following reafons: 1. Becaufe they were included in a membrane like a matrix, fo loofely, that by opening it with the finger or a knife, the internal bladder, containing the ferum or lympha, feemed nowhere to have any connection with it, but would very readily drop out, ftill retaining its liquor without fpilling any. 2. This internal bladder had a neck or white body, more opaque than the reft, and protuberant from it, with an orifice at its extremity; by which, as with a mouth, it exhaufted the ferum from the external membrane, and fo fupplied its bladder or ftomach. 3. On bringing this neck near the candle, it moved and fhortened itfelf. It is found in the abdomen of fheep, fwine, mice, &c. lying between the peritoneum and the inteftines.

The *ftentorea*, or funnel-like polype, is of three colours, green, blue, and white; but the laft is the moft common. They do not form clufters, but adhere fingly by the tail to whatever comes in their way: the anterior end is wider than the pofterior; and, being round, gives the animal fomewhat of a funnel form, though the circle is interrupted by a kind of flit or gap. The edge of this gap is furrounded with a great number of little fimbrillæ, which by their motions excite a current of water, that forces into the mouth of the animal the fmall bodies that come within its reach. Mr Trembley fays, that he has often feen a great number of animalcules fall into the mouths of thefe creatures; fome of which were let out again at an opening which he could not defcribe. They can fafhion their mouths into feveral different forms; and they multiply by dividing neither tranfverfely nor longitudinally, but diagonally.

The *focialis* is defcribed by Muller under the title of *vorticella*. They are found in clufters; and when viewed by a microfcope, appear like a circle furrounded with crowns or ciliated heads, tied by fmall thin tails to a common centre, from whence they advance towards the circumference, and then turn like a wheel, occafioning a vortex which brings along with it the food proper for them. Polypus.

The *anaftatica*, or cluftering polypes, form a group refembling a clufter, or rather an open flower, fupported by a ftem, which is fixed by its lower extremity to fome of the aquatic plants or extraneous bodies that are found in the water; the upper extremity is formed into eight or nine lateral branches, perfectly fimilar to each other, which have alfo fubordinate branches, whofe collective form much refembles that of a leaf. Every one of thefe affemblages is compofed of one principal branch or nerve, which makes the main ftem of the clufter an angle fomewhat larger than a right one: the fmaller lateral branches proceed from both fides of this nerve, and thefe are fhorter the nearer their origin is to the principal branch. There is a polype at the extremity, and others on both fides of the lateral twigs, but at different diftances from their extremities. They are all exceedingly fmall, and bell-fhaped, with a quick motion about the mouth, though it is impoffible to difcern the caufe of it. See Animalcule, n° 24, 26, Pulex, and Vorticella.

The feveral ftrange properties recorded of this animal, though very furprifing, are, however, none of them peculiar to it alone. The Surinam toad is well known to produce its young, not in the ordinary way, but in cells upon its back. Mr Sherwood has very lately difcovered the fmall eels in four pafte to be without exception full of living young ones. And as to the moft amazing of all its properties, the reproduction of its parts, we know the crab and lobfter, if a leg be broken off, always produce a new one: and Monf. Bonet, Monf. Lyonet, Monf. de Reaumur, and Mr Folkes, have all found, by experiment, that feveral earth and water worms have the fame property, fome of them even when cut into thirty pieces. The urtica marina, or fea-nettle, has been alfo found to have the fame; and the fea ftar-fifh, of which the polype is truly a fpecies, though it had long efcaped the fearches of the naturalifts, was always well known by the fifhermen to have it alfo.

Marine Polypus, is different in form from the frefh-water polype already defcribed; but is nourifhed, increafes, and may be propagated, after the fame manner; Mr Ellis having often found, in his inquiries, that fmall pieces cut off from the living parent, in order to view the feveral parts more accurately, foon gave indications that they contained not only the principles of life, but likewife the faculty of increafing and multiplying into a numerous iffue. It has been lately difcovered and fufficiently proved by Peyffonel, Ellis, Juffieu, Reaumur, Donati, &c. that many of thofe fubftances which had formerly been confidered by naturalifts as marine vegetables or fea-plants, are in reality animal-productions; and that they are formed by polypes of different fhapes and fizes, for their habitation, defence, and propagation. To this clafs may be referred the corals, corallines, keratophyta, efchara, fponges, and alcyonium: nor is it improbable, that the more compact bodies, known by the

Polypus. the common appellations of *ſtar-ſtones*, *brain-ſtones*, *petrified fungi*, and the like, brought from various parts of the Eaſt and Weſt Indies, are of the ſame origin. To this purpoſe Mr Ellis obſerves, that the ocean, in all the warmer latitudes near the ſhore, and wherever it is poſſible to obſerve, abounds ſo much with animal life, that no inanimate body can long remain unoccupied by ſome ſpecies. In thoſe regions, ſhips-bottoms are ſoon covered with the habitations of thouſands of animals: rocks, ſtones, and every thing lifeleſs, are covered with them inſtantly; and even the branches of living vegetables that hang into the water are immediately loaded with the ſpawn of different animals, ſhell-fiſh of various kinds: and ſhell-fiſh themſelves, when they become impotent and old, are the baſis of new colonies of animals, from whoſe attacks they can no longer defend themſelves. For a farther account of this ſyſtem, ſee CORAL and CORALLINES.

Polypus || Polyſyndeton.

POLYPUS of the Heart. See MEDICINE, n° 97, 98, 274, and 290.

POLYSARCIA, or CORPULENCY. See MEDICINE, n° 335.

POLYSCHIDES, or SEA HUNGER. See FUCUS.

POLYSPERMOUS (from πολυ and σπερμα *ſeed)*, in botany, is applied to ſuch plants as have more than four ſeeds ſucceeding each flower, without any certain order or number.

POLYSYLLABLE, in grammar, a word conſiſting of more than three ſyllables; for when a word conſiſts of one, two, or three ſyllables, it is called a *monoſyllable*, a *diſſyllable*, and *triſyllable*.

POLYSYNDETON. See ORATORY, n° 67.

POLYTHEISM,

1 Definition.

THE doctrine of a plurality of gods or inviſible powers ſuperior to man.

"That there exiſt beings, one or many, powerful above the human race, is a propoſition (ſays Lord Kames*) univerſally admitted as true in all ages and among all nations. I boldly call it *univerſal*, notwithſtanding what is reported of ſome groſs ſavages; for reports that contradict what is acknowledged to be general among men, require more able vouchers than a few illiterate voyagers. Among many ſavage tribes, there are no words but for objects of external ſenſe: is it ſurpriſing that ſuch people are incapable of expreſſing their religious perceptions, or any perception of internal ſenſe? The conviction that men have of ſuperior powers, in every country where there are words to expreſs it, is ſo well vouched, that in fair reaſoning it ought to be taken for granted among the few tribes where language is deficient."

* *Sketches of the Hiſt. of Man.*

2 Source of religious principles traced

Theſe are judicious obſervations, of which every man will admit the force who has not ſome favourite ſyſtem to build upon the unſtable foundation which his Lordſhip overturns. Taking it for granted, then, that our conviction of ſuperior powers has long been univerſal, the important queſtion is, From what cauſe it proceeds? The ſame ingenious author ſhows, with great ſtrength of reaſoning, that the operations of nature and the government of this world, which to us loudly proclaim the exiſtence of a Deity, are not ſufficient to account for the univerſal belief of ſuperior beings among ſavage tribes. He is therefore of opinion, that this univerſality of conviction can ſpring only from the image of Deity ſtamped upon the mind of every human being, the ignorant equally with the learned. "Nothing leſs (he ſays) is ſufficient: and the original perception which we have of Deity muſt proceed (he thinks) from an internal ſenſe, which may be termed the *ſenſe of Deity*."

We have elſewhere expreſſed our opinion of that philoſophy which accounts for every phenomenon in human nature, by attributing it to a particular inſtinct (ſee INSTINCT); but to this inſtinct or *ſenſe of Deity*, conſidered as complete evidence, many objections, more than uſually powerful, force themſelves upon us. All nations, except the Jews, were once polytheiſts and idolaters. If therefore his Lordſhip's hypotheſis be admitted, either the doctrine of polytheiſm muſt be true theology, or this inſtinct or ſenſe is of ſuch a nature as to have at different periods of the world miſled all mankind. All ſavage tribes are at preſent polytheiſts and idolaters; but among ſavages every inſtinct appears in greater purity and vigour than among people poliſhed by arts and ſciences; and inſtinct never miſtakes its object. The inſtinct or primary impreſſion of nature, which gives riſe to ſelf-love, affection between the ſexes, love of progeny, &c. has in all nations, and in every period of time, a preciſe and determinate object which it inflexibly purſues. How then comes it to paſs, that this particular inſtinct, which if real is ſurely of as much importance as any other, ſhould have uniformly led thoſe who had no other guide to purſue improper objects, to fall into the groſſeſt errors and the moſt pernicious practices? To no purpoſe are we told, that the ſenſe of Deity, like the moral ſenſe, makes no capital figure among ſavages. There is reaſon to believe that the feeling or perception, which is called the *moral ſenſe*, is not wholly inſtinctive; but whether it be or not, a ſingle inſtance cannot be produced in which it multiplies its objects, or makes even a ſavage expreſs gratitude to a thouſand perſons for benefits which his prince alone had power to confer.

For theſe, and other reaſons which might eaſily be aſſigned, we cannot help thinking, that the firſt religious principles muſt have been derived from a ſource different as well from internal ſenſe as from the deductions of reaſon; from a ſource which the majority of mankind had early forgotten; and which, when it was baniſhed from their minds, left nothing behind it to prevent the very firſt principle of religion from being perverted by various accidents or cauſes, or, in ſome extraordinary concurrence of circumſtances, from being perhaps entirely obliterated. This ſource of religion every conſiſtent Theiſt muſt believe to be revelation. Reaſon, it is acknowledged, and we ſhall afterwards ſhow (ſee RELIGION), could not have introduced ſavages to the knowledge of God; and we have juſt ſeen, that a *ſenſe* of Deity is an hypotheſis clogged with inſuperable difficulties. Yet it is undeniable, that all mankind have believed in ſuperior inviſible powers: and if reaſon and inſtinct be ſet aſide, there remains no other origin of this

3 To revelation.

this univerſal belief than primeval revelation, corrupted, indeed, as it paſſed by oral tradition from father to ſon, in the courſe of many generations. It is no ſlight ſupport to this doctrine, that if there really be a Deity*, it is highly preſumable that he would reveal himſelf to the firſt men—creatures whom he had formed with faculties to adore and to worſhip him. To other animals, the knowledge of a Deity is of no importance; to man, it is of the firſt importance. Were we totally ignorant of a Deity, this world would appear to us a mere chaos. Under the government of a wiſe and benevolent Deity, chance is excluded; and every event appears to be the reſult of eſtabliſhed laws. Good men ſubmit to whatever happens without repining, knowing that every event is ordered by Divine Providence: they ſubmit with entire reſignation; and ſuch reſignation is a ſovereign balſam for every misfortune or evil in life.

Admitting, then, that the knowledge of Deity was originally derived from revelation, and that the firſt men profeſſed pure theiſm, it ſhall be our buſineſs in the preſent article to trace the riſe and progreſs of *polytheiſm* and *idolatry;* and to aſcertain, if we can, the real opinions of the Pagan world concerning that multitude of gods with which they filled heaven, earth, and hell. In this inquiry, though we ſhall have occaſion to appeal to the writings of Moſes, we ſhall attribute to them no other authority than what is due to records of the earlieſt ages, more ancient and authentic than any others which are now extant.

Whether we believe, with the author of the book of Geneſis, that all men have deſcended from the ſame progenitors; or adopt the hypotheſis of modern theoriſts, that there have been ſucceſſive creations of men, and that the *European* derives his origin from one pair, the *Aſiatic* from another, the woolly-headed *African* from a third, and the copper-coloured *American* from a fourth—polytheiſm and idolatry will be ſeen to have ariſen from the ſame cauſes, and to have advanced nearly in the ſame order from one degree of impiety to another. On either ſuppoſition, it muſt be taken for granted, that the original progenitors were inſtructed by their Creator in the truths of genuine theiſm: and there is no room to doubt, but that thoſe truths, ſimple and ſublime as they are, would be conveyed pure from father to ſon as long as the race lived in one family, and were not ſpread over a large extent of country. If any credit be due to the records of antiquity, the primeval inhabitants of this globe lived to ſo great an age, that they muſt have increaſed to a very large number long before the death of the common parent, who would of courſe be the bond of union to the whole ſociety, and whoſe dictates, eſpecially in what related to the origin of his being and the exiſtence of his Creator, would be liſtened to with the utmoſt reſpect by every individual of his numerous progeny.

Many cauſes, however, would conſpire to diſſolve this family, after the death of its anceſtor, into ſeparate and independent tribes, of which ſome would be driven by violence, or would voluntarily wander, to a diſtance from the reſt. From this diſperſion great changes would take place in the opinions of ſome of the tribes reſpecting the object of their religious worſhip. A ſingle family, or a ſmall tribe baniſhed into a deſert wilderneſs (ſuch as the whole earth muſt then have been), would find employment for all their time in providing the means of ſubſiſtence, and in defending themſelves from beaſts of prey. In ſuch circumſtances they would have little *leiſure* for meditation, and, being conſtantly converſant with objects of ſenſe, they would gradually loſe the *power* of meditating upon the ſpiritual nature of that Being by whom their anceſtors had taught them that all things were created. The firſt wanderers would no doubt retain in tolerable purity their original notions of Deity; and they would certainly endeavour to impreſs thoſe notions upon their children: but in circumſtances infinitely more favourable to ſpeculation than theirs could have been, the human mind dwells not long upon notions purely intellectual. We are ſo accuſtomed to ſenſible objects, and to the ideas of ſpace, extenſion, and figure, which they are perpetually impreſſing upon the imagination, that we find it extremely difficult to conceive any being without aſſigning to him a form and a place. Hence a learned writer* has ſuppoſed, that the earlieſt generations of men (even thoſe to whom he contends that frequent revelations were vouchſafed) may have been no better than *anthropomorphites* in their conceptions of the Divine Being.

Polytheiſm.

5 Circumſtances which led to polytheiſm.

* *Biſhop Law in his Conſiderations on the Theory of Religion.*

Be this as it may, it is not conceivable but that the members of thoſe firſt colonies would quickly loſe many of the arts and much of the ſcience which perhaps prevailed in the parent ſtate; and that, fatigued with the contemplation of intellectual objects, they would relieve their overſtrained faculties, by attributing to the Deity a place of abode, if not a human form. To men totally illiterate, the place fitteſt for the habitation of the Deity would undoubtedly appear to be the ſun, the moſt beautiful and glorious object of which they could form any idea; an object, too, from which they could not but be ſenſible that they received the benefits of light and heat, and which experience muſt ſoon have taught them to be in a great meaſure the ſource of vegetation. The great ſpirit therefore inhabiting the ſun, which they would conſider as the *power* of light and heat, was in all probability the firſt object of idolatrous adoration.

6 Firſt ſteps in the progreſs.

From looking upon the ſun as the habitation of their God, they would ſoon proceed to conſider it as his body. Of pure mind entirely ſeparated from matter, men in their circumſtances could not long retain the fainteſt notion; but conſcious each of power in himſelf, and experiencing the effects of power in the ſun, they would naturally conceive that luminary to be animated as their bodies were animated. They would feel his influence when above the horizon; they would ſee him moving from eaſt to weſt; they would conſider him when ſet as gone to take his repoſe: and thoſe exertions and intermiſſions of power being analogous to what they experienced in themſelves, they would look upon the ſun as a real animal. Thus would the Divinity appear to their untutored minds to be a compound being like man, partly corporeal and partly ſpiritual; and as ſoon as they imbibed ſuch notions, though perhaps not before, they may be pronounced to have been abſolute idolaters.

7 The ſpirit of light the firſt god of paganiſm.

When man had once got into this train, their gods would multiply upon them with wonderful rapidity. Darkneſs and cold they could not but perceive to be contrary to light and heat; and not having philoſophy enough to diſtinguiſh between mere privations and poſi-

Magianifm. tive effects, they would confider darknefs and cold as entities equally real with light and heat; and attribute these different and contrary effects to different and contrary powers. Hence the fpirit or power of darknefs was in all probability the fecond god in the Pagan calendar; and as they confidered the power of light as a benevolent principle, the fource of all that is good, they muft have looked upon the contrary power of darknefs as a malevolent fpirit, the fource of all that is evil. This we know from authentic hiftory to have been the belief of the Perfian magi, a very ancient fect, who called their good god *Yazdan*, and alfo *Ormuzd*, and the evil god *Abraman*. Confidering light as the fymbol, or perhaps as the body, of *Ormuzd*, they always worfhipped him before the fire, the fource of light, and efpecially before the fun, the fource of the moft perfect light; and for the fame reafon fires were kept continually burning on his altars. That they fometimes addreffed prayers to the evil principle, we are informed by Plutarch in his life of Themiftocles; but with what particular rites he was worfhipped, or where he was fuppofed to refide, is not fo evident. Certain it is, that his worfhippers held him in deteftation; and when they had occafion to write his name, they always inverted it (uɐɯɐɹqɐ), to denote the malignity of his nature.

8 The fpirit or power of darknefs the fecond.

9 Polytheifm of the Perfian magi.

The principles of the magi, though widely diftant from pure theifm, were much lefs abfurd than thofe of other idolaters. It does not appear that they ever worfhipped their gods by the medium of graven images, or had any other emblems of them than light and darknefs. Indeed we are told by Diogenes Laertius and Clemens Alexandrinus, that they condemned all ftatues and images, allowing fire and water to be the only proper emblems or reprefentatives of their gods. And we learn from Cicero*, that at their inftigation Xerxes was faid to have burnt all the temples of Greece, becaufe the builders of thofe edifices impioufly prefumed to inclofe within walls the gods, to whom all things ought to be open and free, and whofe proper temple is the whole world. To thefe authorities we may add that of all the hiftorians, who agree, that when magianifm was the religion of the court, the Perfian monarchs made war upon images, and upon every emblem of idolatry different from their own.

* *De Legibus*, lib. ii. § 10.

The Magi, however, were but one fect, and not the largeft fect of ancient idolaters. The worfhip of the fun, as the fource of light and heat, foon introduced into the calendar of divinities the other heavenly bodies, the moon, the planets, and the fixed ftars. Men could not but experience great benefit from thofe luminaries in the abfence of their chief god; and when they had proceeded fo far as to admit two divine principles, a good and an evil, it was natural for minds clouded with fuch prejudices to confider the moon and the ftars as benevolent intelligences, fent to oppofe the power of darknefs whilft their firft and greateft divinity was abfent or afleep. It was thus, as they imagined, that he maintained (for all held that he did maintain) a conftant fuperiority over the evil principle. Though to aftronomers the moon is known to be an opake body of very fmall dimenfions when compared with a planet or a fixed ftar, to the vulgar eye fhe appears much more magnificent than either. By thofe early idolaters fhe was confidered as the divinity fecond in rank and in power; and whilft the fun was worfhipped as the king, fhe was adored as the queen, of heaven.

10 Sabian polytheifm

The earth, confidered as the common mother of all things; the ocean, whofe waters are never at reft; the air, the region of ftorms and tempefts, and indeed all the elements—were gradually added to the number of divinities; not that mankind in this early age had fo far degenerated from the principles of their anceftors as to worfhip brute matter. If fuch worfhip was ever practifed, which to us is hardly conceivable, it was at a later period, when it was confined to the very loweft of the vulgar, in nations otherwife highly civilized. The polytheifts, of whom we now treat, conceived every thing in motion to be animated, and animated by an intelligence powerful in proportion to the magnitude of the body moved.

This fect of idolaters, which remains in fome parts of the Eaft to this day, was known by the name of *Sabians*, which they pretend to have derived from *Sabius* a fon of Seth; and among the books in which their facred doctrines are contained, they have one which they call the book of *Seth*. We need hardly obferve, that thefe are fenfelefs and extravagant fables. The name *Sabian* is undoubtedly derived from the Hebrew word *Tfaba*, which fignifies "a hoft or army;" and this clafs of polytheifts was fo called, becaufe they worfhipped "the hoft of heaven;" the *Tfaba hefemim*, againft which Mofes fo pathetically cautions the people of Ifrael*.

* *Deut.* c. iv.

This fpecies of idolatry is thought to have firft prevailed in Chaldea, and to have been that from which Abraham feparated himfelf, when, at the command of the true God, he "departed from his country, and from his kindred, and from his father's houfe." But as it nowhere appears that the Chaldeans had fallen into the favage ftate before they became polytheifts and idolaters, and as it is certain that they were not favages at the call of Abraham, their early Sabiifm may be thought inconfiftent with the account which we have given of the origin of that fpecies of idolatry. If a great and civilized nation was led to worfhip the hoft of heaven, why fhould that worfhip be fuppofed to have arifen among favages? Theories, however plaufible, cannot be admitted in oppofition to facts.

11 Arofe in Chaldea

True: but we beg leave to reply, that our account of the origin of polytheifm is oppofed by no fact; becaufe we have not fuppofed that the worfhip of the hoft of heaven arofe among favages *only*. That favages, between whom it is impoffible to imagine any intercourfe to have had place, have univerfally worfhipped, as their firft and fupreme divinities, the *fun*, *moon*, and *ftars*, is a fact evinced by every hiftorian and by every traveller; and we have fhown how their rude and uncultivated ftate naturally leads them to that fpecies of idolatry. But there may have been circumftances peculiar to the Chaldeans, which led them likewife to the worfhip of the heavenly hoft, even in a ftate of high civilization.—We judge of the philofophy of the ancients by that of ourfelves, and imagine that the fame refined fyftem of metaphyfics was cultivated by them as by the followers of *Defcartes* and *Locke*. But this is a great miftake; for fo grofs were the notions of early antiquity, that it may be doubted whether there was a fingle man uninfpired, who had any notion of mind as a being diftinct

ſtinct and entirely ſeparated from matter (ſee METAPHYSICS, Part III. c. 4). From ſeveral paſſages in the books of Moſes, we learn, that when in the firſt ages of the world the Supreme Being condeſcended to manifeſt his preſence to men, he generally exhibited ſome ſenſible emblem of his power and glory, and declared his will from the midſt of a preternatural *fire*. It was thus that he appeared to the Jewiſh lawgiver himſelf, when he ſpoke to him from the midſt of a burning buſh; it was by a pillar of cloud and *fire* that he led the Iſraelites from Egypt to the Land of Promiſe; and it was in the midſt of ſmoke, and *fire*, and thunderings, that the law was delivered from Mount Sinai.—That ſuch manifeſtations of the Divine Preſence would be occaſionally made to the deſcendants of Noah who ſettled in Chaldea ſoon after the deluge, muſt appear extremely probable to every one who admits the authority of the Hebrew Scriptures: and he who queſtions that authority, has no right to make the objection to which we now reply; becauſe it is only from the book of Geneſis that we know the Chaldeans to have been a civilized people when they fell into idolatry. All hiſtories agree in repreſenting the inhabitants of Chaldea as at a very early period corrupted by luxury and ſunk in vice. When this happened, we muſt ſuppoſe that the moral Governor of the univerſe would withdraw from them thoſe occaſional manifeſtations of himſelf, and leave them to their own inventions. In ſuch circumſtances, it was not unnatural for a people addicted to the ſtudy of aſtronomy, who had been taught to believe that the Deity frequently appeared to their anceſtors in a flame of fire, to conſider the ſun as the place of his permanent reſidence, if not as his body. But when either opinion was firmly eſtabliſhed, polytheiſm would be its inevitable conſequence, and the progreſs of Sabiiſm would, in the moſt poliſhed nation, be ſuch as we have traced it among ſavage tribes.

From Chaldea the idolatrous worſhip of the hoſt of heaven ſpread itſelf over all the Eaſt, paſſed into Egypt, and thence into Greece; for Plato affirms †, that "the firſt inhabitants of Greece ſeemed to him to have worſhipped no other gods but the ſun, moon, earth, ſtars, and heavens, as moſt barbarous nations (continues he) ſtill do." That Sabiiſm, or the worſhip of the hoſt of heaven, was the firſt ſpecies of idolatry, beſides the probability of the thing, and the many alluſions to it in ſacred Scripture, we have the poſitive evidence of the moſt ancient pagan hiſtorians of whoſe writings any part has been tranſmitted to us. Herodotus *, ſpeaking of the religion of the Perſians, ſays, that "they worſhip the *ſun, moon,* and *earth, fire, water,* and the *winds;* and this adoration they have all along paid from the beginning." He teſtifies the ſame thing of the ſavage Africans, of whom he affirms †, that they all worſhipped the *ſun* and *moon*, and no other divinity. Diodorus Siculus, writing of the Egyptians ‡, tells us, that "the firſt men looking up to the world above them, and terrified and ſtruck with admiration at the nature of the univerſe, ſuppoſed the ſun and moon to be the principal and *eternal gods.*" And Sanchoniathon the Phœnician, a more ancient writer than either of theſe, informs us, in the fragment of his hiſtory preſerved by Euſebius, that "the two firſt mortals were Æon and Protogonus; and their children were Genus and Genea, who inhabited Phœnicia; and when they were ſcorched with the heat, they lifted up their hands to the ſun, whom they believed to be the Lord of Heaven, and called him *Baal-ſamen*, the ſame whom the Greeks call Ζευς."

Statue-worſhip.

Hitherto thoſe divinities were worſhipped in perſon, or, as Dr Prideaux expreſſes it, in their *ſacella*, or ſacred tabernacles; for the votaries of each directed their devotions towards the planet which they ſuppoſed to be animated by the particular intelligence whom they meant to adore. But theſe orbs, by their riſing and ſetting, being as much below the horizon as above it, and their groſsly ignorant worſhippers not ſuppoſing it poſſible that any intelligence, however divine, could exert its influence but in union with ſome body, ſtatues or pillars were ſoon thought of as proper emblems of the abſent gods. Sanchoniathon, in the fragment already quoted, informs us, that "*Hyſpouranios* and his brother *Ouſous*, Phœnician patriarchs, erected two pillars, the one to *fire* and the other to *air* or *wind*, and worſhipped thoſe pillars, pouring out to them libations of the blood of the wild beaſts hunted down in the chace." As theſe early monuments of idolatry were called βαιτυλια, a word evidently derived from the Hebrew *Bethel*, the probability is, that they were altars of looſe ſtones, ſuch as that which was built by Jacob §, and from him received the ſame name. As his was conſecrated to the true God, theirs were conſecrated to the hoſt of heaven; and the form of conſecration ſeems to have been nothing more than the anointing of the ſtone or pillar with oil (A), in the name of the divinity whom it was intended to repreſent. When this ceremony was performed, the ignorant idolaters, who fancied that their gods could not hear them but when they were viſible, ſuppoſed that the intelligences by which the ſun and planets were animated, took poſſeſſion, in ſome inexplicable manner, of the conſecrated pillars, and were as well pleaſed with the prayers and praiſes offered up before thoſe pillars, as with the devotions which were addreſſed towards the luminaries themſelves.—Hence Sanchoniathon calls them *animated* or *living ſtones*, λιθους εμψυχους, from the portion of the Divine Spirit which was believed to reſide in them; and as they were dedicated to the hoſt of heaven, they were generally erected on the tops of mountains; or in countries which, like Egypt, were low and level, they were elevated to a great height by the labour of men.

13 And produced ſtatue-worſhip,

§ *Geneſis*, ch. xxxv.

14 With the idolatry of *high places*.

It has been ſuppoſed, that this practice of raiſing the pillars on *high places* proceeded from a deſire to make the objects of worſhip conſpicuous and magnificent: but we are ſtrongly inclined to believe, that the erectors of βαιτυλια had ſomething farther in view, and that they thought of nothing leſs than to bring the ſacred ſtone or pillar as near as poſſible to the god whom it repreſented. Whatever be in this, we know that the practice itſelf prevailed univerſally through the eaſt; and that there

Uu 2

† *Cratyb.* ... into ... &c.

* ... i. 131.

† ... iv. 188.

‡ ... i.

(A) Hence the proverb of a ſuperſtitious man, παντα λιθον λιπαρον προσκυνει, *he kiſſes or adores every anointed ſtone*; which Arnobius calls *lubricatam lapidem, et ex olivi unguine ſordidatum*.—Stillingfleet's *Origines Sacræ*.

Dæmons.

there was nothing which the Jewiſh legiſlator more ſtrictly enjoined his people to deſtroy, than the altars, ſtatues, and pillars, erected for idolatrous worſhip upon mountains and high places. "Ye ſhall utterly deſtroy (ſays he) all the places wherein the nations which ye ſhall poſſeſs ſerved their gods, upon the *high mountains*, and upon the *hills*, and under every green tree. And ye ſhall overthrow their *altars*, and break down their *pillars*, and burn their *groves* with fire *."

* Deut. xii. 23.

The mention of *groves* by the Hebrew lawgiver, brings to our recollection another ſpecies of idolatry, which was perhaps the ſecond in order, as men deviating from the principles of pure theiſm were more and more intangled in the labyrinths of error. The Chaldeans, Egyptians, and all the eaſtern nations who believed in a ſuperintending providence, imagined that the government of this world, the care of particular nations, and even the ſuperintendence of groves, rivers, and mountains, in each nation, was committed by the gods to a claſs of ſpirits ſuperior to the ſoul of man, but inferior to thoſe heavenly intelligences which animated the ſun, the moon, and the planets. Theſe ſpirits were by the Greeks called δαιμονες, *dæmons*, and by the Romans *genii*. Timæus the Locrian, who flouriſhed before Plato, ſpeaking of the puniſhment of wicked men, ſays†, all theſe things hath Nemeſis decreed to be executed in the ſecond period, by the miniſtry of vindictive terreſtrial dæmons, who are overſeers of human affairs; to which dæmons the Supreme God, the ruler over all, hath committed the government and adminiſtration of this world, which is made up of *gods*, *men*, and *animals*.

† De Anima Mundi, inter ſcript. a T. Gale, editos.

15
Origin of dæmon-worſhip

Concerning the origin of theſe intermediate beings, ſcholars and philoſophers have framed various hypotheſes. The belief of their exiſtence may have been derived from five different ſources.

1. It ſeems to have been impoſſible for the limited capacities of thoſe men, who could not form a notion of a God diveſted of a body and a place, to conceive how the influence and agency of ſuch a being could every inſtant extend to every point of the univerſe. Hence, as we have ſeen, they placed the heavenly regions under the government of a multitude of heavenly gods, the *ſun*, the *moon*, and the *ſtars*. But as the neareſt of thoſe divinities was at an immenſe diſtance from the earth, and as the intelligence animating the earth itſelf had ſufficient employment in regulating the general affairs of the whole globe, a notion inſinuated itſelf into the untutored mind, that theſe ſuperior governors of univerſal nature found it neceſſary, or at leaſt expedient, to employ ſubordinate intelligences or *dæmons* as miniſters to execute their beheſts in the various parts of their widely extended dominions.

2. Such an univerſal and uninterrupted courſe of action, as was deemed neceſſary to adminiſter the affairs of the univerſe, would be judged altogether inconſiſtent with that ſtate of *indolence*, which, eſpecially in the eaſt, was held an indiſpenſable ingredient in perfect felicity. It was this notion, abſurd as it is, which made Epicurus deny the *providence*, whilſt he admitted the *exiſtence*, of gods. And if it had ſuch an effect upon a philoſopher who in the moſt enlightened ages had many followers, we need not ſurely wonder if it made untaught idolaters imagine that the governor or governors of the univerſe had devolved a great part of their trouble on deputies and miniſters.

3. When men came to reflect on the infinite diſtance between themſelves and the gods, they would naturally form a wiſh, that there might ſomewhere exiſt a claſs of intermediate intelligences, whom they might employ as mediators and interceſſors with their far diſtant divinities. But what men earneſtly wiſh, they very readily believe. Hence the ſuppoſed diſtance of their gods would, among untutored barbarians, prove a fruitful ſource of intermediate intelligences, more pure and more elevated than human ſouls.

4. Theſe three opinions may be denominated popular; but that which we are now to ſtate, wherever it may have prevailed, was the offspring of philoſophy.—On this earth we perceive a ſcale of beings riſing gradually above each other in perfection, from mere brute matter through the various ſpecies of foſſils, vegetables, inſects, fiſhes, birds, and beaſts, up to man. But the diſtance between man and God is infinite, and capable of admitting numberleſs orders of intelligences, all ſuperior to the human ſoul, and each riſing gradually above the other till they reach that point, wherever it may be, at which creation ſtops. Part of this immenſe chaſm the philoſophers perceived to be actually filled by the heavenly bodies; for in *philoſophical* polytheiſm there was one inviſible God ſupreme over all theſe: but ſtill there was left an immenſe vacuity between the human ſpecies and the moon, which was known to be the loweſt of the heavenly hoſt; and this they imagined muſt certainly be occupied by inviſible inhabitants of different orders and diſpoſitions, which they called good and evil *dæmons*.

5. There is yet another ſource from which the univerſal belief of good and evil demons may be derived, with perhaps greater probability than from any or all of theſe. If the Moſaic account of the creation of the world, the peopling of the earth, and the diſperſion of mankind, be admitted as true (and a more conſiſtent account has not as yet been given or deviſed), ſome knowledge of good and evil *angels* muſt neceſſarily have been tranſmitted from father to ſon by the channel of oral tradition. This tradition would be corrupted at the ſame time, and in the ſame manner, with others of greater importance. When the true God was ſo far miſtaken as to be conſidered, not as the ſole governor of the univerſe, but only as the ſelf-extant power of light and good, the Devil would be elevated from the rank of a rebellious created ſpirit to that of the independent power of darkneſs and evil; the angels of light would be transformed into good demons, and thoſe of darkneſs into demons that are evil. This account of the origin of dæmonology receives no ſmall ſupport from Plato, who derives one branch of it wholly from tradition. "With reſpect to thoſe demons (ſays he ‡) who inhabit the ſpace between the earth and the moon, to underſtand and declare their generation is a taſk too arduous for my ſlender abilities. In this caſe we muſt credit the report of men of other times, who, according to their own account, were the deſcendants of the gods, and had, by ſome means or other, gained exact intelligence of that myſtery from their anceſtors. We muſt not queſtion the veracity of the children of the gods, even though they ſhould tranſgreſs the bounds

‡ Tim.

 of

of probability, and produce no evidence to support their assertions. We must, I say, notwithstanding, give them credit, because they profess to give a detail of facts with which they are intimately acquainted, and the laws of our country oblige us to believe them."

Though these dæmons were generally invisible, they were not supposed to be pure disembodied spirits.—Proclus, in his Commentary upon Plato's Timæus, tells us, that "every dæmon superior to human souls consisted of an intellectual mind and an ethereal vehicle." Indeed it is very little probable, that those who gave a body and a place to the Supreme God, should have thought that the inferior orders of his ministers were spirits entirely separated from matter. Plato himself divides the class of dæmons into three orders *; and whilst he holds their souls to be particles or emanations from the divine essence, he affirms that the bodies of each order of dæmons are composed of that particular element in which they for the most part reside. "Those of the first and highest order are composed of pure ether; those of the second order consist of grosser air; and dæmons of the third or lowest rank have vehicles extracted from the element of water. Dæmons of the first and second orders are invisible to mankind. The aquatic dæmons, being invested with vehicles of grosser materials, are sometimes visible and sometimes invisible. When they do appear, though faintly observable by the human eye, they strike the beholder with terror and astonishment." Dæmons of this last order were supposed to have passions and affections similar to those of men; and though all nature was full of them, they were believed to have local attachments to mountains, *rivers*, and *groves*, where their appearances were most frequent. The reason of these attachments seems to be obvious. Polytheism took its rise in countries scorched by a burning sun; and dæmons by their composition being necessarily subject in some degree to the influence of heat and cold, it was natural to suppose that they, like men, would delight in the shady grove and in the purling stream. Hence the earliest altars of paganism were generally built in the midst of *groves*, or on the banks of *rivers*; because it was believed that in such places were assembled multitudes of those intelligences, whose office it was to regulate the affairs of men, and to carry the prayers and oblations of the devout to the far-distant residence of the celestial gods. Hence too are to be derived the mountain and river gods, with the dryads and hamadryads, the satyrs, nymphs, and fawns, which held a place in the creed of ancient paganism, and make so conspicuous a figure in the Greek and Roman poets.

16 ...roves, on the ...ks of ...rs.

These different orders of intelligences, which, though worshipped as gods or demigods, were yet believed to partake of human passions and appetites, led the way to the deification of departed heroes and other eminent benefactors of the human race. By the philosophers all souls were believed to be emanations from the divinity; but "gratitude † and admiration, the warmest and most active affections of our nature, concurred to enlarge the object of religious worship, and to make man regard the inventors of arts and the founders of society as having in them more than a common ray of the divinity. So that god-like benefits, bespeaking as it were a god-like mind, the deceased parent of a people was easily advanced into the rank of a dæmon. When the religious bias was in so good a train, natural affection would have its share in promoting this new mode of adoration. Piety to parents would naturally take the lead, as it was supported by gratitude and admiration, the *primum mobile* of the whole system: and in those early ages, the *natural father* of the tribe often happened to be the *political father* of the people, and the founder of the state. Fondness for the offspring would next have its turn; and a disconsolate father, at the head of a people, would contrive to sooth his grief for the untimely death of a favourite child, and to gratify his pride under the want of *succession*, by paying divine honours to its memory." "For a father ‡ afflicted with untimely mourning, when he had made an image of his child soon taken away, now honoured him as a god, who was then a dead man, and delivered to those that were under him ceremonies and sacrifices." That this was the origin and progress of the worship of departed souls, we have the authority of the famous fragment of Sanchoniathon already quoted, where the various motives for this species of idolatry are recounted in express words. "After many generations (says he) came *Chrysor*; and he invented many things useful to civil life, for which, after his decease, he was worshipped as a *god*. Then flourished *Ouranos* and his sister *Ge*, who deified and offered sacrifices to their father *Hypsistos*, when he had been torn in pieces by wild beasts. Afterwards *Cronos* consecrated *Muth* his son, and was himself consecrated by his subjects."

17 ...ication ...eparted ...es,

Worship.

‡ *Wisdom of Solomon*, xiv. 15.

† *Warburton Div.*

In the reign of Cronos flourished a personage of great reputation for wisdom, who by the Egyptians was called *Thoth*, by the Phœnicians *Taautos*, and by the Greeks *Hermes*. According to Plutarch, he was a profound politician, and chief counsellor to Osiris, then the king, and afterwards the principal divinity, of Egypt: and we are told by *Philo Byblius*, the translator of Sanchoniathon, "that it was this *Thoth* or *Hermes* who first took the matters of religious worship out the hands of unskilful men, and brought them into due method and order." His object was to make religion serviceable to the interests of the state. With this view he appointed *Osiris* and other departed princes to be joined with the stars and worshipped as gods; and being by Cronos made king of Egypt, he was, after his death, worshipped himself as a god by the Egyptians. To this honour, if what is recorded of him be true, he had indeed a better title than most princes; for he is said to have been the inventor of letters, arithmetic, geometry, astronomy, and hieroglyphics, and was therefore one of the greatest benefactors of the human race which any age or country has ever produced.

18 A political invention, which introduced

That the gods of Greece and Rome were derived from Egypt and Phœnicia, is so universally known, that it is needless to multiply quotations in order to prove that the progress of polytheism among the Greeks and Romans was the same with that which we have traced in more ancient nations. The following translation, however, of the account given by Hesiod of the deification of departed heroes, with which we have been favoured by a learned and ingenious friend, is so just, and in our opinion so beautiful, that we cannot deny ourselves the pleasure of giving it to our readers.

"The gods who dwell on high Olympus' hill,
First fram'd a golden race of men, who liv'd
Under old Saturn's calm auspicious sway.
Like gods they liv'd, their hearts devoid of care,

Beyond

Hero-

Beyond the reach of pain and piercing woes;
Th' infirmities of age nor felt, nor fear'd.
Their nerves with youthful vigour strung, their days
In jocund mirth they past, remote from ills.—
Now when this godlike race was lodg'd in earth,
By Jove's high will to demigods they rose,
And airy dæmons, who benign on earth
Converse—the guides and guardians of mankind.
In darkness veil'd, they range earth's utmost bound,
Dispensing wealth to mortals. This reward
From bounteous Jove awaits illustrious deeds ||."

|| Εργων και ἡμερων, lib. i. verf. 100, &c.

The deification of departed heroes and statesmen was that which in all probability introduced the universal belief of *national* and *tutelar* gods, as well as the practice of worshipping those gods through the medium of *statues* cut into a *human figure*. When the founder of a state or any other public benefactor was elevated to the rank of a god, as he was believed still to retain human passions and affections, it was extremely natural to suppose that he would regard with a favourable eye that nation for which he had done so much upon earth; that he would oppose its enemies, and protect the laws and institutions which he himself had given it. By indulging the same train of sentiment, each city, and even every family of consequence, found *Lares* and *Penates* among their departed ancestors, to whom they paid the warmest adoration, and under whose protection they believed their private affairs to be placed. As those national and household gods were believed to be in their deified state clothed with airy bodies, so those bodies were supposed to retain the form which their grosser bodies had upon earth. The image of a departed friend might perhaps be formed by the hand of sorrowful affection, before the statue or the shrine of a deity was thought of; but when that friend or benefactor became the object of religious adoration, it was natural for his votaries to enliven their devotion by the view of his similitude. Maximus Tyrius tells us §, that "there is no race of men, whether barbarian or Grecian, living on the sea-coast or on the continent, wandering in deserts or living in cities, which hath not consecrated some kind of symbol or other in honour of the gods." This is certainly true; but there is no good evidence that the first symbols of the gods were statues of men and women. Whilst the sun and other heavenly bodies continued to be the sole objects of religious worship, the symbols consecrated to them were pillars of a *conical* or *pyramidal* figure; and if such pillars are ever called *graven* images by Moses and other ancient writers, it was probably on account of the *allegoric figures* and *characters*, or hieroglyphic writing, with which they were inscribed.

19 National and tutelar gods.

§ *Differt.* 38.

Hitherto we have considered the souls of departed heroes as holding the rank only of demons or demigods; but they gradually rose in the scale of divinities, till they dethroned the heavenly bodies, and became themselves the *dii majorum gentium*. This revolution was effected by the combined operation of the prince and the priest; and the first step taken towards it seems to have been the complimenting of their heroes and public benefactors with the name of that being which was most esteemed and worshipped. "Thus a king for his beneficence was called the *sun*, and a queen for her beauty the *moon*. Diodorus relates, that Sol first reigned in Egypt, called so from the luminary of that name in the heavens. This will help us to understand an odd passage in the fragment of Sanchoniathon, where it is said that *Cronus had seven sons by Rhea, the youngest of whom was a* GOD *as soon as* BORN. The meaning probably is, that this youngest son was called after some luminary in the heavens to which they paid divine honours; and these honours came in process of time to be transferred to the terrestrial namesake. The same historian had before told us, that the sons of Genos, mortals like their father, were called by the names of the elements—*light*, *fire*, and *flame*, of which they had discovered the use."

20 Hero-worship engrafted on the planetary,

Wor

"As this adulation advanced into an established worship, they turned the compliment the other way, and called the planet or luminary after the hero, the better to accustom the people, even in the act of *Planet-worship*, to this *new* adoration. Diodorus, in the passage already quoted, having told us, that by the first inhabitants of Egypt the sun and moon were supposed to be the principal and eternal gods, adds, that the former was called OSIRIS, and the latter ISIS. This was indeed the general practice; for we learn from Macrobius, that the Ammonites called the sun *Moloch*; the Syrians *Adad*; the Arabs *Dionysus*; the Assyrians *Belus*; the Phœnicians *Saturn*; the Carthaginians *Hercules*; and the Palmyrians *Elegabalus*. Again, by the Phrygians the moon was called *Cybele*, or the mother of the gods; by the Athenians *Minerva*; by the Cyprians *Venus*; by the Cretans *Diana*; by the Sicilians *Proserpine*; by others *Hecate*, *Bellona*, *Vesta*, *Urania*, *Lucina*, &c. Philo Byblius explains this practice: "It is remarkable (says he) that the ancient idolaters imposed on the *elements*, and on those parts of nature which they esteemed gods, *the names of their kings*: for the natural gods which they acknowledged were only the sun, moon, planets, elements, and the like; they being now in the humour of having gods of both classes, the *mortal* and the *immortal*."

21 Whic time i plante

"As a farther proof that *hero*-worship was thus superinduced upon the *planetary*, it is worthy of observation, that the first statues consecrated to the *greater* hero-gods—those who were supposed to be *supreme*—were not of a human form, but *conical* or *pyramidal*, like those which in the earliest ages of idolatry were dedicated to the sun and planets. Thus the scholiast on the Vespæ of Aristophanes tells us, that the statues of Apollo and Bacchus were *conic* pillars or obelisks; and Pausanias, that the statue of Jupiter Meilichius represented a *pyramid*; that of the Argive Juno did the same, as appears from a verse of Phoronis quoted by Clemens Alexandrinus ‡; and indeed the practice was universal as well amongst the early barbarians as amongst the Greeks. But it is well known that the ancients represented the *rays of light* by pillars of a conical or pyramidal form; and therefore it follows, that when they erected such pillars as representatives of their hero-gods, these latter had succeeded to the titles, rights, and honours of the *natural* and *celestial divinities* *."

‡ *Strom*

* *Warton's D. Leg.* b sect. 6

But though it seems to be certain that *hero*-worship was thus engrafted on the *planetary*, and that some of those heroes in process of time supplanted the planets themselves, this was such a revolution in theology as could not have been suddenly effected by the united influence of the prince and the priest. We doubt not the

the fact that SOL was believed to have reigned in Egypt, and was afterwards worſhipped under the name of *Oſiris*; but it was ſurely impoſſible to perſuade any nation, however ſtupid or prone to idolatry, that a man, whom they *remembered* diſcharging the duties of their ſovereign and legiſlator, was the identical ſun whom they beheld in the heavens. Oſiris, if there was in Egypt a king of that name, may have been deified immediately after his death, and honoured with that worſhip which was paid to good *dæmons*; but he muſt have been dead for ages before any attempt was made to perſuade the nation that he was the *ſupreme God*. Even then great addreſs would be requiſite to make ſuch an attempt ſucceſsful. The prince or prieſt who entered upon it would probably begin with declaring from the oracle, that the divine intelligence which animates and governs the ſun had deſcended to earth and animated the perſon of their renowned legiſlator; and that, after their laws were framed, and the other purpoſes ſerved for which the deſcent was made, the ſame intelligence had returned to its original reſidence and employment among the celeſtials. The poſſibility of this double tranſmigration from heaven to earth and from earth to heaven, would without difficulty be admitted in an age when the pre-exiſtence of ſouls was the univerſal belief. Having proceeded thus far in the apotheoſis of dead men, the next ſtep taken in order to render it in ſome degree probable that the early founders of ſtates, and inventors of arts, were divine intelligences clothed with human bodies, was to attribute to one ſuch benefactor of mankind the actions of many of the ſame name. Voſſius, who employed vaſt erudition and much time on the ſubject, has proved, that before the æra of the Trojan wars moſt kings who were very powerful, or highly renowned for their ſkill in legiſlation, &c. were called *Jove*; and when the actions of all theſe were attributed to one *Jove* of *Crete*, it would be eaſy for the crafty prieſt, ſupported by all the power and influence of the ſtate, to perſuade an ignorant and barbarous people, that he whoſe wiſdom and heroic exploits ſo far ſurpaſſed thoſe of ordinary men muſt have been the ſupreme God in human form.

23 ...s of the ...n gods

This ſhort ſketch of the progreſs of polytheiſm and idolatry will enable the reader to account for many circumſtances recorded of the pagan gods of antiquity, which at firſt view ſeem very ſurpriſing, and which at laſt brought the whole ſyſtem into contempt among the philoſophers of Athens and Rome. The circumſtances to which we allude are the immoral characters of thoſe divinities, and the abominable rites with which they were worſhipped. Jupiter, Apollo, Mars, and the whole rabble of them, are deſcribed by the poets as raviſhers of women and notorious adulterers. Hermes or Mercury was a thief, and the god of thieves. Venus was a proſtitute, and Bacchus a drunkard. The malice and revenge of Juno were implacable; and ſo little regard was any of them ſuppoſed to pay to the laws of honour and rectitude, that it was a common practice of the Romans, when beſieging a town, to evocate the tutelar deity, and to tempt him by a reward to betray his friends and votaries †. In a word, they were, in the language of the poet,

> " Gods partial, changeful, paſſionate, unjuſt,
> " Whoſe attributes were rage, revenge, and luſt ‡."

† *Livii*, ... c. 21. *Macrob.* ... iii. c. 9.

This was the natural conſequence of their origin. Having once animated human bodies, and being ſuppoſed ſtill to retain human paſſions and appetites, they were believed, in their ſtate of deification, to feel the ſame ſenſual deſires which they had felt upon earth, and to purſue the ſame means for their gratification. As the men could not well attempt to ſurpaſs the gods in purity and virtue, they were eaſily perſuaded by artful and profligate prieſts, that the moſt acceptable worſhip which could be rendered to any particular deity was to imitate the example of that deity, and to indulge in the practices over which he preſided. Hence the worſhip of Bacchus was performed during the night by men and women mixing in the dark after intemperate eating and drinking ||. Hence too it was the practice in Cyprus and ſome other countries to ſacrifice to Venus * the virginity of young women ſome days before their marriage, in order, as it was pretended, to ſecure their chaſtity ever afterwards; and, if Herodotus may be credited, every woman among the Babylonians was obliged once in her life to proſtitute herſelf in the temple of the goddeſs *Mylitte* (Venus), that ſhe might thenceforward be proof againſt all temptation.

Worſhip. 24 Accounted for.

25 Progreſs of idolatry regular and univerſal.

The progreſs of polytheiſm, as far as we have traced it, has been regular; and after the enormous error of forſaking the worſhip of the true God was admitted, every ſubſequent ſtep appears to be natural. It would be no difficult taſk to prove that it has likewiſe been univerſal. Sir William Jones, the learned preſident of the Aſiatic Society, has diſcovered ſuch a ſtriking reſemblance between the gods of ancient Greece and thoſe of the pagans of Hindoſtan †, as puts it beyond a doubt that thoſe divinities had the ſame origin. The GANESA of the Hindoos he has clearly proved to be the JANUS of the Greeks and Romans. As the latter was repreſented with two and ſometimes with four faces, as emblems of prudence and circumſpection, the former is painted with an elephant's head, the well-known ſymbol among the Indians of ſagacious diſcernment. The SATURN of Greece and Rome appears to have been the ſame perſonage with the MENU or SATYAVRATA of Hindoſtan, whoſe patronymic name is VAIVASWATA, or *child of the ſun*; which ſufficiently marks his origin. Among the Romans there were many Jupiters, of whom one appears from Ennius to have been nothing more than the firmament perſonified.

† *Aſiatic Reſearches*, vol. i.

26 Indian idolatry.

> Aſpice hoc ſublime candens, quem invocant omnes JOVEM.

But this Jupiter had the ſame attributes with the Indian god of the viſible heavens called INDRA or the *king*, and DIVESPETIR or the *lord of the ſky*, whoſe conſort is *Sachi*, and whoſe weapon is *vajra* or the thunderbolt. INDRA is the regent of winds and ſhowers; and though the eaſt is peculiarly under his care, yet his Olympus is the north-pole, allegorically repreſented as a mountain of gold and gems. With all his power he is conſidered as a ſubordinate deity, and far inferior to the Indian triad BRAHMA, VISHNOU, and MAHADEVA or SIVA *, who are three forms of one and the ſame godhead. The preſident having traced the reſemblance between the idolatry of Rome and India through many other gods, obſerves, that " we muſt not be ſurpriſed at finding, on a cloſe examination, that the characters of all the pagan deities melt into each other, and at laſt into

* Plate CCCCXI.

Hero Worſhip.

into one or two; for it ſeems a well-founded opinion, that the whole crowd of gods and goddeſſes in ancient Rome, and likewiſe in Hindoſtan, mean only the powers of nature, and principally thoſe of the ſun, expreſſed in a variety of ways, and by a multitude of fanciful names."

Nor is it only in Greece, Rome, Egypt, and India, that the progreſs of idolatry has been from planetary to hero-worſhip. From every account which modern travellers have given us of the religion of ſavage nations, it appears that thoſe nations adore, as their firſt and greateſt gods, the ſun, moon, and ſtars; and that ſuch of them as have any other divinities have proceeded in the ſame road with the celebrated nations of antiquity, from the worſhip of the heavenly bodies to that of celeſtial demons, and from celeſtial demons to the deification of dead men. It appears likewiſe that they univerſally believe their hero-gods and demigods to retain the paſſions, appetites, and propenſities of men.

27 Scandinavian and Saxon idolatry.

That the Scandinavians and our Saxon anceſtors had the ſame notions of the gods with the other pagans whoſe opinions we have ſtated, is evident from their calling the days of the week by the names of their divinities, and from the forms of the ſtatues by which thoſe divinities were repreſented *. 1. The idol of the ſun, from which *Sunday* is derived, among the Latins *dies Solis*, was placed in a temple, and adored and ſacrificed to; for they believed that the ſun did co-operate with this idol. He was repreſented like a man half naked, with his face like the ſun, holding a burning wheel with both hands on his breaſt, ſignifying his courſe round the world; and by its fiery gleams, the light and heat with which he warms and nouriſheth all things.—2. The idol of the moon, from which cometh our *Monday*, *dies Lunæ*, anciently *Moonday*, appears ſtrangely ſingular, being habited in a ſhort coat like a man. Her holding a moon expreſſes what ſhe is; but the reaſon of her ſhort coat and long-eared cap is loſt in oblivion.—3. *Tuiſco*, the moſt ancient and peculiar god of the Germans, repreſented in his garment of a ſkin according to their ancient manner of clothing, was next to the ſun and moon, the idol of higheſt rank in the calendar of northern paganiſm. To him the third day in the week was dedicated; and hence is derived the name *Tueſday*, anciently *Tuiſday*, called in Latin *dies Martis*, though it muſt be confeſſed that Mars does not ſo much reſemble this divinity as he does Odin or Woden.

* Plate CCCCXI.

4. *Woden* was a valiant prince among the Saxons. His image was prayed to for victory over their enemies; which, if they obtained, they uſually ſacrificed the priſoners taken in battle to him. Our *Wedneſday* is derived from him, anciently *Wodneſday*. The northern hiſtories make him the father of *Thor*, and *Friga* to be his wife.

5. *Thor* was placed in a large hall, ſitting on a bed canopied over, with a crown of gold on his head, and 12 ſtars over it, holding a ſceptre in the right hand. To him was attributed the power over both heaven and earth; and that as he was pleaſed or diſpleaſed he could ſend thunder, tempeſts, plagues, &c. or fair, ſeaſonable weather, and cauſe fertility. From him our *Thurſday* derives its name, anciently *Thorſday*; among the Romans *dies Jovis*, as this idol may be ſubſtituted for Jupiter.

Brute Worſhip.

6. *Friga* repreſented both ſexes, holding a drawn ſword in the right hand and a bow in the left; denoting that women as well as men ſhould fight in time of need. She was generally taken for a goddeſs; and was reputed the giver of peace and plenty, and cauſer of love and amity. Her day of worſhip was called by the Saxons *Frigedeag*, now *Friday*, *dies Veneris*; but the habit and weapons of this figure have a reſemblance of Diana rather than Venus.

7. *Seater*, or *Crodo*, ſtood on the prickly back of a perch. He was thin-viſaged and long-haired, with a long beard, bare-headed and bare-footed, carrying a pail of water in his right hand wherein are fruit and flowers, and holding up a wheel in his left, and his coat tied with a long girdle. His ſtanding on the ſharp fins of this fiſh ſignified to the Saxons, that by worſhipping him they ſhould paſs through all dangers unhurt; by his girdle flying both ways was ſhown the Saxons freedom; and by the pail with fruit and flowers, was denoted that he would nouriſh the earth. From him, or from the Roman deity Saturn, comes *Saturday*.

Such were the principal gods of the northern nations: but theſe people had at the ſame time inferior deities, who were ſuppoſed to have been tranſlated into heaven for their heroic deeds, and whoſe greateſt happineſs conſiſted in drinking *ale* out of the ſkulls of their enemies in the *hall of Woden*. But the limits preſcribed to the preſent article do not permit us to purſue this ſubject; nor is it neceſſary that we ſhould purſue it. The attentive reader of the article Mythology, of the hiſtories given in this work of the various divinities of paganiſm, and of the different nations by whom thoſe divinities were worſhipped, will perceive that the progreſs of polytheiſm and idolatry has been uniform over the whole earth.

There is, however, one ſpecies of idolatry more wonderful than any thing that has yet been mentioned, of which our readers will certainly expect ſome account. 28
It is the worſhip of *brutes*, *reptiles*, and *vegetables*, among the Egyptians. To the Greeks and Romans, as well as to us, that ſuperſtition appeared ſo monſtrous, that to enumerate every hypotheſis, ancient and modern, by which philoſophers have endeavoured to account for it, would ſwell this article beyond all proportion. Brute-worſhip prevailed at ſo early a period in Egypt, that the philoſophers of antiquity, whoſe writings have deſcended to us, had little or no advantage over the moderns in purſuing their reſearches into its origin; and among the modern hypotheſes, thoſe of *Moſheim* and *Warburton* appear to us by much the moſt probable of any that we have ſeen (B). The former of theſe learned writers attributes it wholly to the policy of the prince and

Brute-worſhip of the Egyptians.

(B) There is, however, another hypotheſis worthy of ſome attention, if it were only for the learning and ingenuity of its author. The celebrated Cudworth infers, from the writings of Philo and other Platoniſts of the Alexandrian ſchool, that the ancient Egyptians held the Platonic doctrine of ideas exiſting from eternity, and conſtituting, in one of the perſons of the godhead, the intelligible and archetypal world. (See Platonism.) Philo,

Brute-Worship.

and the craft of the prieſt. The latter contends, with much earneſtneſs and ingenuity, that it reſulted from the uſe of hieroglyphic writing. We are ſtrongly inclined to believe that both theſe cauſes contributed to the production of ſo portentous an effect; and that the uſe of hieroglyphics as ſacred ſymbols, after they were laid aſide in civil life, completed that wonderful ſuperſtition which the craft of the prieſt and the policy of the prince had undoubtedly begun.

Lib. 2. 65. 29 Introduced with a political view.

We learn from Herodotus *, that in his time the number of uſeful animals in Egypt was ſo ſmall as hardly to be ſufficient for tillage and the other purpoſes of civil life; whilſt ſerpents and other noxious animals, ſuch as the crocodile, wolf, bear, and hippopotamus, abounded in that country. From this fact Moſheim very naturally concludes †, that the founders of ſociety and government in Egypt would by every art endeavour to increaſe the number of uſeful animals as the number of inhabitants increaſed; and that with this view they would make it criminal to kill or even to hurt ſheep, cows, oxen, or goats, &c. whilſt they would wage perpetual war upon the noxious animals and beaſts of prey. Such animals as were aſſiſting to them in the carrying on of this warfare would be juſtly conſidered as in a high degree uſeful to ſociety. Hence the moſt grievous puniſhments were decreed againſt the killing, or ſo much as the wounding, of the *ichneumon* and *ibis;* becauſe the former was looked upon as the inſtinctive enemy of the crocodile, and the latter of every ſpecies of ſerpents *. The learned writer, however, obſerves, that in Egypt as in other countries, people would be tempted to ſacrifice the good of the public to the gratification of their own appetites, and ſometimes even to the indulgence of a momentary caprice. Hence he thinks it was found neceſſary to ſtrengthen the authority of the laws enacted for the preſervation of uſeful animals by the ſanctions of religion: and he ſays, that with this view the prieſts declared that certain animals were under the immediate protection of certain gods; that ſome of thoſe animals had a divine virtue reſiding in them; and that they could not be killed without the moſt ſacrilegious wickedneſs, incurring the higheſt indignation of the gods. When once the idolatrous Egyptians were perſuaded that certain animals were ſacred to the immortal gods, and had a divine virtue reſiding in them, they could not avoid viewing thoſe animals with ſome degree of veneration; and the prieſts, taking advantage of the ſuperſtition of the people, appointed for each ſpecies of ſacred animals appropriated rites and ceremonies, which were quickly followed with building ſhrines and temples to them, and approaching them with oblations, and ſacrifices, and other rites of divine adoration.

Cudworth, Intellect. System, cap. 4. 158.

See Ichneumon and Ibis.

To corroborate this hypotheſis, he obſerves, that, beſides the animals ſacred over all Egypt, each province and each city had its particular animal to which the inhabitants paid their devotions. This aroſe from the univerſal practice among idolaters of conſecrating to themſelves *Lares* and *Penates;* and as the animals which were worſhipped over the whole kingdom were conſidered as ſacred to the *Dii majorum gentium*, ſo the animals whoſe worſhip was confined to particular cities or provinces were ſacred to the *Lares* of thoſe cities and provinces. Hence there was in Upper Egypt a city called *Lycopolis*, becauſe its inhabitants worſhipped the wolf, whilſt the inhabitants of *Thebes* or *Heliopolis* paid their devotions to the eagle, which was probably looked upon as ſacred to the ſun. Our author, however, holds it as a fact which will admit of no diſpute, that there was not one noxious animal or beaſt of prey worſhipped by the Egyptians till after the conqueſt of their country by the Perſians. That the earlieſt gods of Egypt were all benevolent beings, he appeals to the teſtimony of Diodorus Siculus; but he quotes Herodotus and Plutarch, as agreeing that the latter Egyptians worſhipped an evil principle under the name of *Typhon*. This *Typhon* was the inveterate enemy of *Oſiris*, juſt as *Ahraman* was of *Ormuzd;* and therefore he thinks it in the higheſt degree probable that the Egyptians derived their belief of two ſelf-exiſtent principles, a good and an evil, from their Perſian conquerors, among whom that opinion prevailed from the earlieſt ages.

From whatever ſource their belief was derived, Typhon was certainly worſhipped in Egypt, not with a view of obtaining from him any good, for there was nothing good in his nature, but in hopes of keeping him quiet, and averting much evil. As certain animals had long been ſacred to all the benevolent deities, it was natural for a people ſo beſotted with ſuperſtition as the Egyptians to conſecrate emblems of the ſame kind to their god Typhon. Hence aroſe the worſhip of *ſerpents*, *crocodiles*, *bears*, and other noxious animals and beaſts of prey. It may indeed ſeem at firſt ſight very inconſiſtent to deify ſuch animals, after they had been in the practice for ages of worſhipping others for being their

---

Philo, he obſerves, did not himſelf conſider thoſe ideas as ſo many diſtinct *ſubſtances* and *animals*, much leſs as *gods;* but he mentions others who deified the whole of this intelligible ſyſtem as well as its ſeveral parts. Hence, when they paid their devotions to the *ſenſible ſun*, they pretended to worſhip only the divine *idea* or *archetype* of that luminary: and hence, thinks our learned author, the ancient Egyptians, by falling down to bulls, and cows, and crocodiles, meant at firſt to worſhip only the divine and eternal *ideas* of thoſe animals. He allows, indeed, that as few could entertain any thoughts at all of thoſe eternal ideas, there were ſcarcely any who could perſuade themſelves that the *intelligible ſyſtem* had ſo much reality in it as the *ſenſible things of nature;* and hence he thinks the devotion which was originally paid to the divine ideas had afterwards no higher object than the brutes and vegetables of which thoſe ideas were the eternal patterns.

This hypotheſis is ingenious, but not ſatisfactory. There is no evidence that the myſterious doctrine of Plato concerning *ideas* had anywhere been thought of for ages after brute-worſhip was eſtabliſhed in Egypt. Of the ſtate of Egyptian theology at that early period, Philo, and the other philoſophers of the Alexandrian ſchool, had no better means of forming a judgment than we have; and they laboured under many Grecian prejudices, which muſt have prevented them from judging with our impartiality.

their deſtroyers; but it is to be remembered, that long before the deification of crocodiles, &c. the real origin of brute worſhip was totally forgotten by the people, if they were ever acquainted with it. The crafty prieſt who wiſhes to introduce a gainful ſuperſtition, muſt at firſt employ ſome plauſible reaſon to delude the multitude; but after the ſuperſtition has been long and firmly eſtabliſhed, it is obviouſly his buſineſs to keep its origin out of ſight.

Such is Moſheim's account of the origin and progreſs of that ſpecies of idolatry which was peculiar to Egypt; and with reſpect to the *riſe* of *brute* worſhip, it appears perfectly ſatisfactory. But the Egyptians worſhipped ſeveral ſpecies of vegetables; and it ſurely could be no part of the policy of wiſe legiſlators to preſerve *them* from deſtruction, as vegetables are uſeful only as they contribute to animal ſubſiſtence. We are therefore obliged to call in the aid of Warburton's hypotheſis to account for this branch of Egyptian ſuperſtition.

30 Continued by the means of hieroglyphic writing, and

That learned and ingenious author having proved *, with great clearneſs and ſtrength of argument, that hieroglyphic writing was prior to the invention of alphabetic characters; and having traced that kind of writing from ſuch rude pictures, as thoſe which were in uſe among the Mexicans, through all the different ſpecies of what he calls *euriologic*, *tropical*, and *ſymbolic* hieroglyphics (ſee HIEROGLYPHICS)—ſhows, by many quotations from ancient authors, that the Egyptian prieſts wrapt up their theology in the ſymbolic hieroglyphics, after alphabetic characters had baniſhed from the tranſactions of civil life a mode of communicating information neceſſarily ſo obſcure. Theſe ſymbols were the figures of animals and vegetables, denoting, from ſome imaginary analogy, certain attributes of their divinities; and when the vulgar, forgetting this analogy, ceaſed to underſtand them as a ſpecies of writing, and were yet taught to conſider them as ſacred, they could not well view them in any other light than as emblems of the divinities whom they adored. But if rude ſculptures upon ſtone could be emblematical of the divinities, it was ſurely not unnatural to infer, that the living animals and vegetables which thoſe ſculptures repreſented muſt be emblems of the ſame divinities more ſtriking and more ſacred. Hence the learned author thinks aroſe that wonderful ſuperſtition peculiar to the Egyptians, which made them worſhip not only animals and vegetables, but alſo a thouſand chimeras of their own creation; ſuch as figures with human bodies and the heads or feet of brutes, or with brutal bodies and the heads and feet of men.

* *Div. Leg.* book 4th, ſect. 4th.

Theſe two hypotheſes combined together appear to us to account ſufficiently for the idolatry of Egypt, monſtrous as it was. We are perſuaded, that with reſpect to the *origin* of brute-worſhip, Moſheim is in the right (c); and it was a very eaſy ſtep for people in ſo good training to proceed upon the crutches of hieroglyphics to the worſhip of plants and thoſe chimeras, which, as they never had a real exiſtence in nature, could not have been thought of as emblems of the divinity, had they not been uſed in that ſymbolic writing which Warburton ſo ably and ingeniouſly explains.

To this account of the origin of brute-worſhip we are fully aware that objections will occur. From a learned friend, who peruſed the article in manuſcript, we have been favoured with one which, as it is exceedingly plauſible, we ſhall endeavour to obviate. "Brute-worſhip was not peculiar to Egypt. The Hindoos, it is well known, have a religious veneration for the cow and the alligator; but there is no evidence that in India the number of uſeful animals was ever ſo ſmall as to make the interference of the prince and the prieſt neceſſary for their preſervation; neither does it appear that the Hindoos adopted from any other people the worſhip of a ſelf-exiſtent principle of evil." Such is the objection. To which we reply, 31

Carried from Egypt into India.

That there is every reaſon to believe that brute-worſhip was introduced into India by a colony of Egyptians at a very remote period. That between theſe two nations there was an early intercourſe, is univerſally allowed: and though the learned preſident of the Aſiatic Society has laboured to prove, that the Egyptians derived all that wiſdom for which they were famed, as well as the rudiments of their religious ſyſtem, from the natives of Hindoſtan, he does not appear to us to have laboured with ſucceſs. To examine his arguments at length would ſwell this article beyond its due proportion; and we have noticed ſome of them elſewhere (ſee PHILOLOGY, n° 33 and 39.) At preſent we ſhall only obſerve, that Seſoſtris undoubtedly made an inroad into India, and conquered part of the country, whilſt we nowhere read of the Hindoos having at any time conquered the kingdom of Egypt. Now, though the victors have ſometimes adopted the religion of the vanquiſhed, the contrary has happened ſo much more frequently, and is in itſelf a proceſs ſo much more natural, that this ſingle circumſtance affords a ſtrong preſumption that the Egyptian monarch would rather impoſe his gods upon the Hindoos than adopt theirs and carry them with him to Egypt. Brute-worſhip might likewiſe be introduced into Hindoſtan by thoſe vaſt colonies of Egyptians who took refuge in that country from the tyranny and oppreſſion of the ſhepherd kings. That ſuch colonies did ſettle on ſome occaſion or other in India, ſeems undeniable from monuments ſtill remaining in that country of forms which could hardly have occurred to a native of Aſia, though they are very natural as the workmanſhip of Africans. But we need not reaſon in this manner. We have ſeen a manuſcript letter from Mr Burt, a learned ſurgeon in Bengal, and a member of the Aſiatic Society, which puts it beyond a doubt that great numbers of Egyptians had at a very early

(c) To prove that it was merely to preſerve and increaſe the breed of uſeful animals in Egypt, that the prince and the prieſt *firſt* taught the people to conſider ſuch animals as ſacred, he argues thus: "Hæc ita eſſe, non ex eo tantum liquet, quod paulo ante obſervavi, nullas beſtias univerſo Ægyptiorum populo ſacras fuiſſe, præter eas, quæ manifeſtam regioni utilitatem comparant; ſed inde quoque apparet, quod longe major ratio habita fuit femellarum inter animalia, quam marium. Boves diis immolare licebat, vaccas nullo modo. Canes fœminæ contumulabantur, non item mares." *Lege* HERODOT. *Hiſtor.* lib. ii. cap. 41. & cap. 67.

gony. early period not only fettled in Hindoftan, but alfo brought with them writings relating to the hiftory of their country. As the fhepherd-kings were enemies to the arts and to literature, it is probable that this fettlement took place on their conqueft of Egypt. Mr Burt's words are: "Mr Wilford, lieutenant of engineers, has extracted moft wonderful difcoveries from the Shanfcrit records; fuch as the origin and hiftory of the Egyptian pyramids, and even the account of the expence in their building." Upon our hypothefis there is nothing incredible in this account; upon the hypothefis of Sir William Jones, it is not eafy to be conceived how the hiftory of *Egyptian* pyramids could have found a place in the *Shanfcrit* records.

We may admit that the Hindoos have never adopted from the Perfians or Egyptians the worfhip of an independent principle of evil, and yet difpofe of the other part of the objection with very little difficulty. It will be feen by and bye, that the bramins believe a kind of triad of hypoftafes in the divine nature, of which one is viewed as the *deftroyer*, and known by feveral names, fuch as *Siva* and *Ifwara*. When brute-worfhip was introduced into Hindoftan, it was not unnatural to confider the alligator as emblematical of *Ifwara*; and hence in all probability it is that the Hindoos believe that a man cannot depart more happily from this world than by falling into the Ganges, and being devoured by one of thofe facred animals. Upon the whole, the brute-worfhip of the Hindoos, inftead of militating againft our account of that monftrous fuperftition as it prevailed in Egypt, feems to lend no fmall fupport to that account, as there was unqueftionably an early intercourfe between the two nations, and as colonies of Egyptians fettled in India. To him who is not fatisfied with our reafoning on this fubject, we beg leave to recommend an attentive perufal of Maurice's *Indian Antiquities*, where he will find many facts brought together, which tend to prove that Egypt has a juft claim to a higher antiquity than India.

a heifts w- d one me Having thus traced the rife and progrefs of polytheifm and idolatry as they prevailed in the moft celebrated nations of antiquity, we now proceed to inquire into the real opinions of thofe nations concerning the nature of the gods whom they adored. And here it is evident from the writings of Homer, Hefiod, and the other poets, who were the principal theologians among the Greeks and Romans, that though heaven, earth, hell, and all the elements, were filled with divinities, there was yet one who, whether called *Jove*, *Ofiris*, *Ormuzd*, or by any other title, was confidered as fupreme over all the reft. "Whence each of the gods was generated (fays Herodotus*), or whether they have all exifted from eternity, and what are their *forms*, is a thing that was not known till very lately; for Hefiod and Homer were, as I fuppofe, not above four hundred years my feniors; and thefe were they who introduced the theogony among the Greeks, and gave the gods their feveral names." Now Hefiod†, towards the beginning of his theogony, exprefsly invokes his mufe to celebrate in fuitable numbers the generation of the immortal gods who had fprung from the earth, the dark night, the ftarry heavens, and the falt fea. He calls upon her likewife to fay, "in what manner the gods, the earth, the rivers, ocean, ftars, and firmament, were generated, and what divine intelligences had fprung from them of benevolent difpofitions towards mankind." From this invocation, it is evident that the poet did not confider the gods of Greece as felf-exiftent beings: neither could he look upon them as *creatures*; for of creation the ancient Greeks had no conception (fee METAPHYSICS, n° 264.); but he confidered them as emanations coeval with the earth and heavens, from fome fuperior principles; and by the divine intelligences fprung from them, there cannot be a doubt but that he underftood benevolent dæmons. The firft principles of all things, according to the fame Hefiod, were *Chaos*, and *Tartarus*, and *Love*; of which only the laft being active, muft undoubtedly have been conceived by this father of Grecian polytheifm to be the greateft and only felf-exifting god. This we fay muft undoubtedly have been Hefiod's belief, unlefs by *Tartarus* we here underftand a felf-exiftent principle of evil; and in that cafe his creed will be the fame with that of the ancient Perfians, who, as we have feen, believed in the felf-exiftence as well of *Ahraman* as of *Ormuzd*.

. 2.

Theogony.

† Verf. 104—112.

33 From whom the other divinities were generated;

Hefiod is fuppofed to have taken his theology from Orpheus; and it is evident that his doctrine concerning the generation of the gods is the fame with that taught in certain verfes* ufually attributed to Orpheus, in which Love and Chaos are thus brought together. "We will firft fing (fays the poet) a pleafant and delightful fong concerning the ancient Chaos, how the heavens, earth, and feas, were formed out of it; as alfo concerning that all-wife *Love*, the oldeft and felf-perfect principle, which actively produced all thefe things, feparating one from another." In the original paffage, Love is faid not only to be πολυμητις of *much wifdom* or *fagacity*, and therefore a real intelligent fubftance; but alfo to be πρεσβυτατος and αυτοτελης the *oldeft* and *felf-perfect*, and therefore a being of fuperior order to the other divinities who were generated together with the elements over which they were conceived to prefide.

* Argonaut. pag. 17. ed. Steph.

With the theology of Homer our readers of all defcriptions are fo well acquainted, that we need not fwell the article with quotations, to prove that the father of epic poetry held *Jove* to be the father of gods and men. But the doctrine of the poets was the creed of the vulgar Greeks and Romans; and therefore we may conclude, that thofe nations, though they worfhipped gods and lords innumerable, admitted but one, or at the moft two (D), felf-exiftent principles; the one good and the other evil. It does not indeed appear, that in the fyftem

(D) Plutarch is commonly fuppofed, and we think juftly fuppofed, to have been a believer in two felf-exiftent principles, a good and an evil. His own opinion, whatever it was, he declares *(de Ifide et Ofiride)* to have been moft ancient and univerfal, and derived from theologers and lawgivers by poets and philofophers. "Though the firft author of it be unknown, yet (fays he) it hath been fo firmly believed *every-where*, that traces of it are to be found in the facrifices and myfteries both of the *barbarians* and the *Greeks*. There is a confufed mixture of good and evil in every thing, and nothing is produced by nature *pure*. Where-fore

Theogony

system of vulgar paganism the subordinate gods were accountable to their chief for any part of their conduct, except when they transgressed the limits of the provinces assigned them. Venus might conduct the amours of heaven and earth in whatever manner she pleased; Minerva might communicate or with-hold wisdom from any individual with or without reason; and we find, that in Homer's battles the gods were permitted to separate into parties, and to support the Greeks or Trojans according as they favoured the one or the other nation. Jove indeed sometimes called them to order; but his interference was thought partial, and an instance of tyrannical force rather than of just authority. The vulgar Greeks, therefore, although they admitted but one, or at most two, self-existent principles, did not consider the inferior divinities as mediators between them and the supreme, but as gods to whom their worship was on certain occasions to be ultimately directed.

34 Though each was by the vulgar considered as unaccountable in his own province.

35 Creed of the philosophers and

The creed of the philosophers seems to have been different. Such of them as were theists, and believed in the administration of Providence, admitted of but one God, to whom worship was ultimately due; and they adored the subordinate divinities as his children and ministers, by whom the course of Providence was carried on. With respect to the origin of those divinities, Plato is very explicit; where he tells us*, that "when all the gods, both those who move visibly round the heavens, and those who appear to us as often as they please, were generated, that God, who made the whole universe, spoke to them after this manner: Ye gods of gods, of whom I myself am father, attend." Cicero teaches the very same doctrine with Plato concerning the gods†; and Maximus Tyrius, who seems to have understood the genius of polytheism as thoroughly as any man, gives us the following clear account of that system as received by the philosophers.

* *Timæus.*

† *Tusc. Quæst.* lib. 1. c 2; *et de Nat. Deorum, passim*

‡ *Dissert.* 1

"I will now more plainly declare my sense‡ by this similitude: Imagine a great and powerful kingdom or principality, in which all agree freely and with one consent to direct their actions according to the will and command of one supreme king, the oldest and the best; and then suppose the bounds and limits of this empire not to be the river Halys, nor the Hellespont, nor the Meotian lake, nor the shores of the ocean; but heaven above, and the earth beneath. Here then let that great king sit immoveable, prescribing to all his subjects laws, in the observance of which consist their safety and happiness: the partakers of his empire being many, both visible and invisible gods; some of which that are nearest, and immediately attending on him, are in the highest regal dignity, feasting as it were at the same table; others again are their ministers and attendants; and a third sort are inferior to them both: and thus you see how the order and chain of this government descends down by steps and degrees from the supreme God to the earth and men." In this passage we have a plain acknowledgment of one supreme God, the sovereign of the universe, and of three inferior orders of gods, who were his ministers in the government of the world; and it is worthy of observation, that the same writer calls these intelligences θεους θεου παιδας και φιλους, *gods, the sons and friends of God.* He likewise affirms, that all ranks of men, and all nations on earth, whether barbarous or civilized, held the same opinions respecting one supreme Numen and the generation of the other gods.

"If there were a meeting (says he*) called of all these several professions, a painter, a statuary, a poet, and a philosopher, and all of them were required to declare their sense concerning *the God;* do you think that the painter would say one thing, the statuary another, the poet a third, and the philosopher a fourth? No; nor the Scythian neither, nor the Greek, nor the Hyperborean. In other things we find men speaking very discordantly, all men as it were differing from all. But amidst this war, contention, and discord, you may find everywhere, throughout the whole world, one uniform law and opinion, that there is ONE GOD, THE KING AND FATHER OF ALL, and many gods, the SONS OF GOD, who reign with God. These things both the Greek and barbarian affirm, both the inhabitants of the continent and of the sea-coast, both the wise and the unwise."

* *Ibid.*

36 Indian Brahmins.

This account of philosophical polytheism receives no small support from the Asiatic Researches of Sir William Jones. "It must always be remembered (says that accomplished scholar), that the learned Indians, as they are instructed by their own books, acknowledge only

---

fore it is not one only dispenser of things, who, as it were, out of several vessels distributeth these several liquors of good and evil, mingling them together, and dashing them as he pleases; but there are two distinct and contrary powers or principles in the world, one of them always leading, as it were, to the right hand, but the other tugging the contrary way. For if nothing can be made without a cause, and that which is good cannot be the cause of evil, there must needs be a distinct principle in nature for the production of evil as well as good."

That this is palpable manicheism (see MANICHEISM), appears to us so very evident, as to admit of no debate. It appeared in the same light to the learned Cudworth; but that author labours to prove that Plutarch mistook the sense of Pythagoras, Empedocles, Heraclitus, Anaxagoras, and Plato, when he attributed to them the same opinions which were held by himself. Mosheim, on the other hand, has put it beyond a doubt, that whatever was Plutarch's belief respecting the origin of evil and the existence of two independent principles, it was taken implicitly from the writings of Plato. But the pious chancellor of *Gottingen,* actuated by the same motives with Cudworth, wishes to persuade his readers, that by Plato and Plutarch nothing *active* was understood by their evil principle but only *that tendency to confusion,* which was then deemed inseparable from matter. But that something more was meant seems undeniable; for immediately after the words which we have quoted, Plutarch proceeds to affirm that the wisest men declare θεους ειναι δυο καθαπερ αντιτεχνους, *that there are two gods, as it were of contrary trades or crafts,* of which one is the author of all good and the other of all evil. See *Mosheim. ed. Cudworth. System. Intellect.* lib. i. cap. 4. § 13.

only one supreme Being, whom they call BRAHME, or THE GREAT ONE, in the neuter gender. They believe his essence to be infinitely removed from the comprehension of any mind but his own; and they suppose him to manifest his power by the operation of his divine spirit, whom they name VISHNOU the *pervader*, and NE'RA'YAN or *moving on the waters*, both in the masculine gender; whence he is often denominated the *first male*. When they consider the divine power as exerted in *creating* or giving existence to that which existed not before, they call the deity BRAHMA'; when they view him in the light of *destroyer*, or rather *changer of forms*, they give him a thousand names, of which SIVA, ISWARA, and MAHADEVA, are the most common; and when they consider him as the preserver of created things, they give him the name of VISHNOU. As the soul of the world, or the pervading *mind*, so finely described by Virgil, we see JOVE represented by several Roman poets; and with great sublimity by Lucan in the well known speech of Cato concerning the Ammonian oracle. 'Jupiter is wherever we look, wherever we move.' This is precisely the Indian idea of VISHNOU: for since the power of preserving created things by a superintending providence belongs eminently to the godhead, they hold that power to exist transcendantly in the *preserving* member of the triad, whom they suppose to be EVERYWHERE ALWAYS, not in substance, but in spirit and energy." This supreme god BRAHME, in his triple form, is the only selfexistent divinity acknowledged by the philosophical Hindoos. The other divinities GENESA, INDRA, CUVERA, &c. are all looked upon either as his creatures or his children; and of course are worshipped only with inferior adoration.

37 It was upon this principle of the generation of the gods, and of their acting as ministers to the supreme *Numen*, that all the philosophers of Greece, who were not atheists, worshipped many divinities, though they either openly condemned or secretly despised the traditions of the poets respecting the amours and villanies of Jupiter, Venus, Mercury, and the rest of the tribe. It was the same principle sincerely admitted, and not an ill-timed jest, as has been absurdly supposed, that made Socrates, after he had swallowed the poison, request his friend to offer a votive cock for him to Esculapius.

But a theogony was not peculiar to the Greeks, Romans, and the Hindoos; it made part of every system of polytheism. Even the Egyptians themselves, the grossest of all idolaters, believed in one self-existing God, from whom all their other divinities descended by generation. This appears probable from the writings of Horus Apollo, Jamblicus, Porphyry, and many other ancient authors; but if the inscription on the gates of the temple of *Neith* in *Sais*, as we have it from Plutarch and Proclus, be genuine, it will admit of no doubt. This famous inscription, according to the last of these writers, was to this purpose: "I am whatever is, whatever shall be, and whatever hath been. My veil no man hath removed. The offspring which I brought forth was the sun (E)."

The Persian magi, as we have seen, believed in two self-existent principles, a good and an evil: but if Diogenes Laertius deserves to be credited, they held that fire, earth, and water, which they called gods, were generated of these two. It was observed in the beginning of this article, that the first object of idolatrous worship was probably the sun, and that this species of idolatry took its rise in Chaldea or Persia. But when it became the practice of eastern monarchs to conceal themselves wholly from their people, the custom, as implying dignity, was supposed to prevail as well in heaven as on earth; and Zoroaster, the reformer of the Persian theology, taught*, that "Ormuzd was as far removed from the sun as the sun is removed from the earth." According to this modification of magianism, the sun was one of the generated gods, and held the office of prime minister or vicegerent to the invisible fountain of light and good. Still, however, a self-existent principle of evil was admitted; but though he could not be destroyed or annihilated by any power, it was believed that he would at last be completely vanquished by Ormuzd and his ministers, and rendered thenceforward incapable of producing any mischief.

* *Plutarch, de Iside et Osir.*

From this short view of polytheism, as we find it delineated by the best writers of antiquity, we think ourselves warranted to conclude, that the whole pagan world believed in but *one*, or at most *two*, SELF-EXISTENT GODS, from whom they conceived all the other divinities to have descended in a manner analogous to human generation. It appears, however, that the vulgar pagans considered each divinity as supreme and unaccountable within his own province, and therefore intitled to worship, which rested ultimately in himself.

38 Vulgar polytheists less culpable than the philosophers.

The philosophers, on the other hand, seem to have viewed the inferior gods as accountable for every part of their conduct to him who was their sire and sovereign, and to have paid to them only that inferior kind of devotion which the church of Rome pays to departed saints. The vulgar pagans were sunk in the grossest ignorance, from which statesmen, priests, and poets, exerted their utmost influence to keep them from emerging; for it was a maxim which, however absurd, was universally received, that "there were many things true in religion*, which it was not convenient for the vulgar to know; and some things which, though false, it was yet expedient that they should believe." The polytheism and idolatry of the vulgar, therefore, was their misfortune rather than their fault. But the philosophers were wholly "without excuse*; because that when they knew God, they glorified him not as God, neither were thankful, but became vain in their imaginations, and their foolish heart was darkened. Professing themselves wise, they became fools, and worshipped and served the creature more than the Creator, who is God blessed for ever."

* *Varro apud D. August. de Civ. Dei.*

* *Rom.* i. 20, 21, 22, 25.

POLY-

(E) Τα οντα, και τα εσομενα, και τα γεγονοτα εγω ειμι. Τον εμον χιτωνα ουδεις απεκαλυψεν. Ὁν εγω καρπον ετεκον, ἡλιος εγενετο. The antiquity of this inscription is admitted by Cudworth, denied by Mosheim, and doubted by Jablonski. The reader who wishes to know their arguments may consult Mosheim's edition of the *Intellectual System*, and Jablonski's *Pantheon Ægyptiorum*.

POLYTRICHUM, in botany: A genus of the order of musci, belonging to the cryptogamia class of plants. The anthera is operculated, and placed upon a very small apophysis or articulation; the calyptra villous; the star of the female is on a distinct individual. There are three species; the most remarkable of which is the commune, or great golden maiden-hair, frequently to be met with in the bogs and wet places of this country. It grows in patches, the stalks erect, generally single and unbranched, from three inches to a foot, or even a yard high. The leaves are numerous, stiff, lanceolate, acute, growing round the stalk without order, and, if viewed with a microscope, appear to have their edges finely serrated. They are of a bright green when young and fresh, but reddish when dried or in decay: the filaments, or peduncles, are of a shining red, or orange colour, from two to four inches long, arising singly from the top of the stalks, and surrounded at their base with a cylindrical tubular vagina, or perichætium. The anthera, or capsule, is quadrangular, green at first, afterwards yellow, and red when ripe, having an annular pedestal, or apophysis, at its base. The operculum is flat, with a projecting point in the centre; and underneath is a whitish circular membrane, placed in the middle of the capsule's orifice, and sustained there by numerous arched threads, or cilia, connected by one end to the circumference of this membrane, and by the other fastened to the ring of the anthera. The pollen, or, as others term it, the seed, is freed from the anthera or capsule through the space between the cilia. The calyptra is twofold, an internal and external one; both which at first entirely cover and hang over the anthera. The internal one is conical, membranaceous, and smooth; the external one is composed only of tawny hairs, connected into a sort of mat, lacerated at the base, and serving like a roof of thatch to defend the other. Besides the stalks before described, there are commonly some others near at hand, which are destitute both of filaments and capsules, but are terminated with a kind of rosaceous cup, either of a bright red or yellowish colour, composed of leaves of different sizes, the outermost broad, the innermost lanceolate, growing gradually more and more fine and slender to the centre. This cup is looked upon by Linnæus as the female flower of this moss; but Haller is of opinion, that it is only the gem or origin of a new stalk, which frequently rises from its centre, and this again becomes sometimes proliferous. There are two varieties of this moss: the first has much shorter stalks than the preceding, and often branched; the leaves stiffer, erect, and more crowded; in other respects the same. The other has a stalk scarcely more than half an inch high, terminated with a cluster of linear, erect, rigid leaves, for the most part entire on the edges, and tipped each with a white hair. The filament is about an inch high, and the capsule quadrangular. The female flower, or gem, is of a bright red colour.

The first kind, when it grows long enough for the purpose, is sometimes used in England and Holland to make brooms or brushes. Of the female sort the Laplanders, when obliged to sleep in desert places, frequently make a speedy and convenient bed. Their manner of doing it is curious: Where this moss grows thick together, they mark out, with a knife, a piece of ground, about two yards square, or of the size of a common blanket; then beginning at one corner, they gently sever the turf from the ground, and as the roots of the moss are closely interwoven and matted together, they by degrees strip off the whole circumscribed turf in one entire piece; afterwards they mark and draw up another piece, exactly corresponding with the first; then, shaking them both with their hands, they lay one upon the ground, with the moss uppermost, instead of a matrass, and the other over it, with the moss downwards, instead of a rug; and between them both take a comfortable nap, free from fleas and bugs, and without fear of contagious distempers. It is probable they might take the hint of making such a bed from the bear, a cohabitant of their country, which prepares his winter-quarters with a large collection of this same moss. See MUSCI, p. 473. and Plate CCCXXI.

POLYXÆNUS, or POLYÆNUS. See POLYÆNUS.

POLYXO, a priestess of Apollo's temple in Lemnos. She was likewise nurse to queen Hypsipyle. It was by her advice that the Lemnian women murdered all their husbands.——There was another Polyxo, a native of Argos, who married Tlepolemus son of Hercules. She followed him to Rhodes after the murder of his uncle Licymnius; and when he departed for the Trojan war with the rest of the Greek princes, she became the sole mistress of the kingdom. After the Trojan war, Helen fled from Peloponnesus to Rhodes, where Polyxo reigned. Polyxo detained her; and to punish her as being the cause of a war in which Tlepolemus had perished, she ordered her to be hanged on a tree by her female servants, disguised in the habit of Furies.

POMACEÆ, (*pomum* "an apple,") the name of the 36th order in Linnæus's Fragments of a Natural Method, the genera of which have a pulpy esculent fruit of the apple, berry, and cherry kind. See BOTANY, Sect. vi. p. 465.

POMATUM, an unguent generally used in dressing the hair. It is also used as a medicine. See PHARMACY, n° 636, &c.

POMEGRANATE. See PUNICA.

POMERANIA, a province of Germany, in the circle of Upper Saxony, with the title of a duchy. It is bounded on the north by the Baltic Sea, on the east by Prussia and Poland, on the south by the marquisate of Brandenburg, and on the west by the duchy of Mecklenburg; and is about 250 miles in length, and in some places 75 miles and in others 50 in breadth. It is watered by several rivers, the most considerable of which are the Oder, the Pene, the Rega, the Persant, the Wipper, the Stolp, the Lupo, and the Lobo. The air is cold; but the soil abounds in pastures, and produces corn, of which a great deal is exported. It is a flat country; containing many lakes, woods, and forests, and has several good harbours. It is divided into the Hither and Farther Pomerania, and the territories of the kings of Sweden and Prussia in this duchy are divided by the river Pene.

POMET (Peter), an able druggist at Paris, was born in 1658. He collected at a great expence from all countries drugs of every kind, and rendered himself celebrated by his book entitled *Histoire Generale des Drogues*,

Drogues, which is the moſt complete book on the ſubject that has yet been printed. He gave demonſtrations with reſpect to his drugs in the king's garden, and a catalogue of all the drugs contained in his work, with a liſt of all the rarities of his cabinet, which he propoſed to publiſh by ſubſcription; but was prevented by his death, which happened in 1699, upon the very day when the patent for a penſion granted him by Louis XIV. was made out.

POMFRET (John), an Engliſh poet, ſon of the rector of Luton in Bedfordſhire, was born in 1667, and educated at Cambridge; after which he took orders, and was preſented to the living of Malden in Bedfordſhire. About 1703 he went to London for inſtitution to a larger and very conſiderable living; but was ſtopped ſome time by Compton, then biſhop of London, on account of theſe four lines of his poem, entitled the Choice:

"And as I near approach'd the verge of life,
Some kind relation (for I'd have no wife)
Should take upon him all my wordly care,
While I did for a better ſtate prepare."

The parentheſes in theſe lines were ſo maliciouſly repreſented, that the good biſhop was made to believe that Pomfret preferred a miſtreſs to a wife. But he was ſoon convinced that this repreſentation was the mere effect of malice, as Pomfret at that time was actually married. The oppoſition, however, which his ſlanderers had made to him had its effect; for, being by this obliged to ſtay in London longer than he intended, he catched the ſmallpox, and died of it, aged 35.

He publiſhed a volume of his poems in 1699, with a very modeſt and ſenſible preface. Two pieces of his were publiſhed after his death by his friend Philalethes; one intitled Reaſon, and written in 1700, when the diſputes about the Trinity ran high; the other *Dies Noviſſima*, or the "Laſt Epiphany," a Pindaric ode. His verſification is not unmuſical; but there is not the force in his writings which is neceſſary to conſtitute a poet. A diſſenting teacher of his name, and who publiſhed ſome rhimes upon ſpiritual ſubjects, occaſioned fanaticiſm to be imputed to him; but his friend Philalethes has juſtly cleared him from the imputation. Pomfret had a very ſtrong mixture of devotion in him, but no fanaticiſm.

"The Choice (ſays Dr Johnſon) exhibits a ſyſtem of life adapted to common notions, and equal to common expectations; ſuch a ſtate as affords plenty and tranquillity, without excluſion of intellectual pleaſures. Perhaps no compoſition in our language has been oftener peruſed than Pomfret's Choice. In his other poems there is an eaſy volubility; the pleaſure of ſmooth metre is afforded to the ear, and the mind is not oppreſſed with ponderous, or intangled with intricate, ſentiment. He pleaſes many; and he who pleaſes many muſt have merit."

POMME', or POMMETTE', in heraldry, is a croſs with one or more balls or knobs at each of the ends.

POMMEL, or PUMMEL, in the manege, a piece of braſs or other matter at the top and in the middle of the ſaddle-bow.

POMMERCULLIA, in botany: A genus of the monogynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 4th order, *Gramina*. The calyx is bivalved, and ſhaped like a top; the valvula quadrifid, and bearded on the back. The corolla has two unequal valves; the filaments three, with long pointed antheræ; the ſtyle ſimple. The whole flower forms itſelf into a ſharp point, and the corolla ſerves as a covering to the ſeed, which is long, clear, and ſmooth. There is only one ſpecies, viz. the Dianthoides.

POMŒRIUM, in Roman antiquity, was, according to Livy, that ſpace of ground, both within and without the walls, which the augurs, at the firſt building of cities, ſolemnly conſecrated, and on which no edifices were allowed to be raiſed. Plutarch gives this account of the ceremony of drawing the pomœrium: "They dug a trench, and threw into it the firſt-fruits of all things, either good by cuſtom, or neceſſary by nature; and every man taking a ſmall turf of earth of the country from whence he came, they caſt them in promiſcuouſly. Then making this trench their centre, they deſcribed the city in a circle round it. After this, the founder yoking a bull and a cow together, ploughed a deep furrow, with a brazen ploughſhare, round the bounds. The attendants took care that all the clods fell inwards, *i. e.* toward the city. This furrow they called *pomœrium*, and built the wall upon it."—Plutarch, in this account, is to be underſtood as ſpeaking of Rome.

POMOERIUM Proferre, ſignifies to extend or enlarge a city, which could not be done by any, but thoſe who had taken away ſome part of an enemy's country in war. But this qualification was ſometimes diſpenſed with. *Pomœrium* is *quaſi pone mœnia*, "behind the walls."

POMONA, in fabulous hiſtory, the tutelar deity of orchards and fruit-trees. See VERTUMNUS.

POMPEII (anc. geog.), a town of Campania near Herculaneum, and deſtroyed along with it by the great eruption of Veſuvius in the time of Titus. See HERCULANEUM. It is about 15 miles from Naples, and ſix or ſeven from Portici—So much has been ſaid and written on the diſcovery of this place, as makes it unneceſſary for us to ſay much: we ſhall therefore only give a ſhort extract on the ſubject from an anonymous work lately publiſhed, apparently of conſiderable merit. "On entering the city (ſays our author ‖), the firſt object is a pretty ſquare, with arcades, after the preſent manner of Italy. This was, as it is imagined, the quarter of the ſoldiers; numbers of military weapons being found here.

‖ *Comparative Sketch of England and Italy, with Diſquiſitions on National Advantages.*

"A narrow, but long ſtreet, with ſeveral ſhops on each ſide, is now perfectly cleanſed from its rubbiſh, and in good preſervation. Each houſe has a court. In ſome of them are paintings al freſco, principally in chiaroſcuro; and their colours not in the leaſt injured by time. The few colours which the ancients knew were extracted only from minerals; and this may be a ſufficient reaſon for their freſhneſs. The ſtreet is paved with irregular ſtones of a foot and half or two feet long, like the Appian way.

"In diſcovering this city, it was at firſt doubted whether it were actually Pompeii: but the name inſcribed over the gateway put it beyond all doubt. The

Pompey || Pomponatius.

skeletons found were innumerable. It is said that many had spades in their hands, endeavouring, probably at first, to clear away the torrent of ashes with which they were deluged. Indeed the satisfaction which is felt at the view of ancient habitations, is much allayed by inevitable reflections on this frightful scene of desolation, though at the distance of so many centuries.

"An ancient villa is also seen entire at a little distance from Pompeii. The house is really elegant and spacious, but only two stories high. The pavement of the chambers is composed of tessellated marble, and, when polished, displays the design perfectly well.— There is some at the museum of Portici brought from this place, which the eye would really mistake for painting. Under the house is a fine triangular cellar, of which each part is 100 feet long, well filled with amphoræ. The skeletons of 29 persons were found here, supposed to have fled to it for safety. Each house is filled with ashes: they have almost penetrated through every crevice; and it is incredible how such a volume of them could have been thrown out by Vesuvius with sufficient force to have reached so far." See Swinburne's *Travels in the Two Sicilies*, vol. 2. p. 98, &c.; Lady Miller's *Letters*, or *De La Lande;* Captain Sutherland's *Tour up the Straits, from Gibraltar to Constantinople*, p. 75. &c.; Dr Smith's *Sketch of a Tour on the Continent*, in 1786 and 1787, vol. 2. p. 118, &c.; and Watkins's *Tour through Swisserland, Italy*, &c.

POMPEY the GREAT, (Cneius Pompeius Magnus), the renowned rival of Julius Cæsar. Being defeated by him at the battle of Pharsalia, owing to the defection of his cavalry, he fled to Egypt by sea, where he was basely assassinated by order of Theodotus, prime minister to Ptolemy the Younger, then a minor, 48 B. C *.

* See *Rome.*

POMPEYS (Cneius and Sextus), his sons, commanded a powerful army when they lost their illustrious father. Julius Cæsar pursued them into Spain, and defeated them at the battle of Munda, in which Cneius was slain, 45 B. C. Sextus made himself master of Sicily; but being defeated in the celebrated naval engagement at Actium by Augustus and Lepidus, he fled to Asia with only 7 ships, the remains of his fleet, which consisted of more than 350; and from thence, unable to continue the war, he was obliged to retire to Lesbos, where renewing the war by raising an army, and seizing on some considerable cities, Marcus Titius, in the interest of Marc Antony, gave him battle, defeated him, took him prisoner, and basely put him to death, 35 B. C. See ROME.

POMPEY's-Pillar. See ALEXANDRIA, p. 393.

POMPILUS, in ichthyology, a species of CORYPHOENA.

POMPONATIUS (Peter), an eminent Italian philosopher, was born at Mantua in 1462. He was of so small a stature, that he was little better than a dwarf; yet he possessed an exalted genius, and was considered as one of the greatest philosophers of the age in which he lived. He taught philosophy, first at Padua and afterwards at Bologna, with the highest reputation. He had frequent disputations with the celebrated Achillini, whose puzzling objections would have confounded him, had it not been for his skill in parrying them by some joke. His book *De Immortalitate Animæ*, published in 1516, made a great noise. He maintained, that the immortality of the soul could not be proved by philosophical reasons; but solemnly declared his belief of it as an article of faith. This precaution did not, however, save him; many adversaries rose up against him, who did not scruple to treat him as an atheist; and the monks procured his book, although he wrote several apologies for it, to be burnt at Venice. His book upon Incantations was also thought very dangerous. He shows in it, that he believed nothing of magic and sorcery; and he lays a prodigious stress on occult virtues in certain men, by which they produced miraculous effects. He gives a great many examples of this; but his adversaries do not admit them to be true, or free from magic.— Paul Jovius says, that he died in 1525, in his grand climacteric. He was three times married; and had but one daughter, to whom he left a large sum of money. He used to apply himself to the solution of difficulties so very intensely, that he frequently forgot to eat, drink, sleep, and perform the ordinary functions of nature: nay, it made him almost distracted, and a laughing-stock to every one, as he himself tells us.

Pomponius || Pond.

POMPONIUS MELA. See MELA.

POMUM, an APPLE; a species of seed-vessel, composed of a succulent fleshy pulp; in the middle of which is generally found a membranous capsule, with a number of cells, or cavities, for containing the seeds. Seed-vessels of this kind have no external opening or valve. At the end opposite to the foot-stalk is frequently a small cavity, called by the gardeners the *eye of the fruit*, and by botanists *umbilicus*, the "navel," from its fancied resemblance to the navel in animals. Gourd, cucumber, melon, pomegranate, pear, and apple, furnish instances of the fruit or seed-vessel in question.

POND, or *FISH-Pond.* See *FISH-Ponds.*

POND, is a small pool or lake of water from whence no stream issues. In the *Transactions of the Society instituted at London for the Encouragement of Arts, Manufactures, and Commerce*, vol. viii. and printed in the year 1790, there is a short account of a machine for draining ponds without disturbing the mud. It was communicated to the society, together with a drawing and model of the machine, by Lieutenant-colonel Dansey. The model was made from the description of a machine used by a gentleman near Taunton for many years before, for supplying a cascade in his pleasure-grounds.— The colonel's regiment was then lying at Windsor; and thinking that the invention might be useful to supply the grand cascade at Virginia-water, he made the model, and presented it to the king, who was graciously pleased to approve of it. In consequence of which, by his majesty's desire, a penstock on that principle was constructed from the model at one of the ponds in the neighbourhood.—The colonel thinks the machine may be useful in the hands of men of science, and applicable to silk, cotton, and other mills, where a steady and uniform velocity of water is wanted; which might be regulated at pleasure, occasioning no current to disturb the mud or fish, as the stream constantly runs from the surface. He says he has often made the experiment by the model in a tub of water.

Of this machine we have given an engraving, taken from the above-mentioned Transactions; and we shall now add the description which accompanies the plate in that work.

Plate CCCC

In figure 1. A is the pipe, loaded with a rim of lead, of

of such weight as serves to sink it below the surface of the water. B is the discharging pipe, laid through the bank HI. C is the joint on which the pipe A turns its form, which is shown fig. 2. D is the ball or float, which, swimming on the surface of the pond, prevents the pipe A from descending deeper than the length of the chain by which they are connected. E is a chain winding on the windlass F, and serving to raise the tube A above the surface of the water, when the machinery is not in use. G is a stage. HI is the bank, represented as if cut through at I, to show the tube B lying within it. K is a post to receive the tube A when lowered, and to prevent its sinking in the mud. In figure 2. A is a cast cylinder, with a plate or cheek, B, which is fastened to the timber of the tube on one side, but not on the other, as the part of the cylinder C turns in the hollow of the wooden tube when it is immerged. A piece of strong sole leather is put inside the brass-plate B, to prevent leaking.

Pond-Weed, in botany. See Potamogeton.

PONDICHERRY, is a large town of Asia, in the peninsula on this side the Ganges, and on the coast of Coromandel. Its situation is low, and the ships anchor about a mile and a half from it; nor can the boats or canoes come nearer it than a musket-shot, on account of the breakers, so that the blacks come in flat-bottomed boats to carry the men and merchandises to the fleet. The fort is 200 paces from the sea, and very irregular; built with bricks, and covered with fine plaster, resembling white marble. The huts of the blacks lie here and there, and the walls are of bamboos mixed with the branches of trees. The French are greatly addicted to women, from whom they catch diseases that render them pale, livid, and meagre, with a frightful aspect. However, several of the French are married to a sort of Portuguese women, who are of a mixed breed, being a kind of Mulattoes. The country about it is barren, and consequently most of their provisions are brought from other places. Their trade consists of cotton-cloth, silks, pepper, saltpetre, and other merchandises that are brought from Bengal. With regard to the religion of the natives, the most numerous are the Gentoos; but there are Mahometans or Moors who hold a great many ridiculous opinions. The Gentoos are of different sects, and that of the Brahmins are priests. The custom of women burning themselves with the bodies of their dead husbands was very common, but of late much discountenanced. The slaves or servants are very numerous, and their chief food is rice. This place was taken, and the fortifications demolished, by Colonel Coote; it was restored to the French by the peace of 1763; and was retaken in the beginning of the present war with the French republic. It is 60 miles south of Fort St George. E. Long. 79. 58. N. Lat. 11. 42.

PONDICO, an island of the Archipelago, lying on the gulph of Ziton, near the coast of Negropont. It is small and uninhabited, as well as two others that lie near it.

PONG-hou *Isles*, in the province of Fo-kien in China, form an archipelago between the port of Emouy and the island of Formosa. A Chinese garrison is kept here, with one of those mandarines who are called *literati*, whose principal employment is to watch the trading vessels which pass from China to Formosa, or from Formosa to China.

As these islands are only sand-banks or rocks, the inhabitants are obliged to import every necessary of life; neither shrubs nor bushes are seen upon them; all their ornament consists of one solitary tree. The harbour is good, and sheltered from every wind; it has from 20 to 25 feet depth of water. Although it is an uncultivated and uninhabited island, it is absolutely necessary for the preservation of Formosa, which has no port capable of receiving vessels that draw above eight feet of water.

PONIARD, a little pointed dagger, very sharp edged; borne in the hand, or at the girdle, or hid in the pocket. The word is formed from the French *poignard*, and that from *poignée*, "handful."—The poniard was anciently in very great use; but it is now in a good measure set aside, except among assassins.—Sword and poniard were the ancient arms of duelists; and are said to continue still so among the Spaniards. The practice of sword and poniard still make a part of the exercise taught by the masters of defence.

PONS, a town of France, in Saintonge, very famous in the time of the Huguenots. It is seated on a hill, near the river Suigne, 10 miles from Saintes. W. Long. 0. 30. N. Lat. 45. 36.

PONT-du-Gard, is a bridge of France, in Lower Languedoc, built over the river Gardon, which served for an aqueduct. It is a very remarkable and a most magnificent work, and was raised by the ancient Romans. It consists of three bridges, one above another; the uppermost of which was the aqueduct, to convey water to the city of Nismes, which is eight miles to the south. They are altogether 192 feet high, and the uppermost 580 feet long. They are constructed between two rocks. E. Long. 4. 26. N. Lat. 43. 58.

PONTEDERIA, in botany: A genus of the monogynia order, belonging to the hexandria class of plants; and in the natural method ranking under the sixth order, *Ensatæ*. The corolla is monopetalous, sexfid, bilabiate; there are three stamina inserted into the top, and three into the tube of the corolla; the capsule is bilocular.

PONTEFRACT, or Pomfret, a town of the West Riding of Yorkshire in England, situated on the river Are. It is said to take its name from a broken bridge, which is supposed to have been laid anciently over that marshy spot called the *Wash*. Here are the ruins of a noble old castle, where Richard II. was barbarously murdered, and two of Edward V.'s uncles. The collegiate chapel of St Clement, which had a dean, three prebendaries, &c. is still distinguishable in it. This town has a good market, and fairs for horses, sheep, and other cattle. It is a corporation, governed by a mayor, recorder, aldermen, and burgesses, and gives title of earl to the family of Fermor. In the reign of Queen Elizabeth, 200 l. was left by George Talbot, earl of Shrewsbury, to be lent for ever, at 5 l. a time, on proper security, for three years, to the poor artificers of the town; and Thomas Wentworth, Esq; ancestor to the marquis of Rockingham, left 200 l. to the charity-school. A branch of the great Roman military way called *Erminstreet*, which passed from Lincoln to York, may be traced betwixt this

Pontifex || Pont.

town and Doncaster. The adjacent country yields plenty of limestone, together with liquorice and skirrets. W. Long. 1. 5. N. Lat. 53. 42.

PONTIFEX, Pontiff, or *High-priest*, a person who has the superintendance and direction of divine worship, as the offering of sacrifices and other religious solemnities. The Romans had a college of pontiffs; and over these a sovereign pontiff, or pontifex maximus, instituted by Numa, whose function it was to prescribe the ceremonies each god was to be worshipped withal, compose the rituals, direct the vestals, and for a good while to perform the business of augury, till, on some superstitious occasion, he was prohibited intermeddling therewith. The office of the college of pontiffs was to assist the high-priest in giving judgment in all causes relating to religion, inquiring into the lives and manners of the inferior priests, and punishing them if they saw occasion, &c. The Jews too had their pontiffs; and among the Romanists, the pope is still styled the *sovereign pontiff*.

PONTIFICATE, is used for the state or dignity of a pontiff or high-priest; but more particularly in modern writers for the reign of a pope.

PONTIUS (Pilate.) See Pilate.

PONTON, or Pontoon, in war, a kind of flat bottomed boat, whose carcase of wood is lined within and without with tin: they serve to lay bridges over rivers for the artillery and army to march over. The French pontoons, and those of most other powers, are made of copper on the outside: though these cost more at first, yet they last much longer than those of tin; and when worn out, the copper sells nearly for as much as it cost at first; but when ours are rendered useless, they sell for nothing. Our pontoons are 21 feet long, five feet broad, and depth within two feet 1.5 inches.

Pontoon-Carriage, is made with two wheels only, and two long side-pieces, whose fore-ends are supported by a limber; and serves to carry the pontoon, boards, cross-timbers, anchors, and every other thing necessary for making a bridge.

Pontoon-Bridge, is made of pontoons slipped into the water, and placed about five or six feet asunder; each fastened with an anchor, when the river has a strong current; or to a strong rope that goes across the river, running through the rings of the pontoons. Each boat has an anchor, cable, baulks, and chests. The baulks are about five or six inches square, and 21 feet long. The chests are boards joined together by wooden bars, about three feet broad and 12 feet long. The baulks are laid across the pontoons at some distance from one another, and the chests upon them joined close; which makes a bridge in a very short time, capable of supporting any weight.

PONT St Esprit, is a town of France, in Languedoc, in the diocese of Usez. It is seated on the river Rhone, over which is one of the finest bridges in France. It is 840 yards long, and consists of 26 arches. Each pier is pierced with an aperture, in order to facilitate the passage of the water where the river is high. The town is large, but the streets are narrow and ill-built. It formerly contained several churches and convents. It is 17 miles south of Viviers, and 55 north-east of Montpelier. E. Long. 4. 46. N. Lat. 44. 13.

Pontus.

PONTUS, the name of an ancient kingdom of Asia, originally a part of Cappadocia; bounded on the east by Colchis, on the west by the river Halys, on the north by the Euxine Sea, and on the south by Armenia Minor. Some derive the name of Pontus from the neighbouring sea, commonly called by the Latins *Pontus Euxinus*; others from an ancient king named *Pontus*, who imparted his name both to the country and the sea; but Bochart deduces it from the Phœnician word *botno*, signifying a filberd, as if that nut abounded remarkably in this place. But this derivation seems to be very far fetched; and the common opinion that the country derived its name from the sea, seems by far the most probable. The kingdom was divided into three parts; the first, named *Pontus Galaticus*, extending from the river Halys to the Thermodon; the second, named *Pontus Polemonaicus*, extended from the Thermodon to the borders of *Pontus Cappadocicus*; and this last extended from Pontus Polemonaicus to Colchis, having Armenia Minor and the upper stream of the Euphrates for its southern boundary.

1 Etymology of the name.

It is commonly believed, that the first inhabitants of Pontus were descended from Tubal; but in process of time mixed with Cappadocians, Paphlagonians, and other foreign nations, besides many Greek colonies which settled in those parts, and maintained their liberty till the time of Mithridates the Great and Pharnaces. The first king of this country whom we find mentioned in history is Artabazes, who had the crown bestowed on him by Darius (A) Hystaspes. The next was Rhodobates, who reigned in the time of Darius Nothus. After him came Mithridates, who, refusing to pay the usual tribute to the Persians, was defeated by Artaxerxes Mnemon; but a peace was soon after concluded by the mediation of Tissaphernes. Besides this, we hear nothing of him farther than that he was treacherously taken prisoner by Clearchus afterwards tyrant of Heraclea, and obliged to pay a large sum for his ransom.

2 Artabazes the first king.

Mithridates I. was succeeded by Ariobarzanes, who being appointed by Artaxerxes governor of Lydia, Ionia, and Phrygia, employed the forces that were under his care in the extending of his own dominions, and subduing those of his natural prince. The king of Persia sent one Autophrodates against him; but Ariobarzanes, having with great promises prevailed on Agesilaus and Timothæus the Athenian to come to his assistance, obliged Autophrodates to retire. He then rewarded Agesilaus with a great sum of money, and bestowed on Timothæus the cities of Sestos and Abydos, which he had lately taken from the Persians. He used his utmost endeavours to reconcile the Lacedemonians and Thebans; but not being able to bring the latter to

3 Mithridates I.

(A) This country, together with the adjacent provinces, was in different periods under the dominion of the Assyrians, Medes, and Persians; the last of whom divided Cappadocia into satrapies or governments, and bestowed that division which was afterwards called *Pontus* on one of the ancestors of Mithridates. This regulation was effected in the reign of Darius the son of Hystaspes, and has been regarded as the date of the kingdom.

Pontus. to any reaſonable terms, he aſſiſted the Lacedemonians with vaſt ſums of money. The Athenians ſhowed ſo much reſpect for this prince, that they not only made him free of their city, but granted both him and his children whatever they aſked of them. He was murdered in the 28th year of his reign by one Mithridates, whom authors ſuppoſe to have been his ſon. This happened at the time that Alexander the Great invaded Aſia, ſo that Pontus for a time fell under the power of the Macedonians.

4 iobar- nes akes off e Mace- nian ke.

In the reign of Antigonus, Mithridates the ſon of Ariobarzanes ſhook off the Macedonian yoke; the particulars of which event are related as follow. Antigonus having dreamed that he had a field in which gold grew after the manner of corn, and that Mithridates cut it down and carried it into Pontus, began to be very jealous of him, and ordered him to be put to death privately. But Mithridates, having got notice of the king's intention, withdrew into Paphlagonia, attended only by ſix horſemen. Here, being joined by many others, he poſſeſſed himſelf of Ciniatum, a ſtrong hold ſituated near mount Olgaſys; from whence, as his army continually increaſed, he made an irruption into Cappadocia; and having driven the commanders of Antigonus from that part which borders upon Pontus, he entered his paternal kingdom, which, in ſpite of the utmoſt efforts of Antigonus, he held for the ſpace of 26 years, and tranſmitted to his poſterity.

Under the reigns of Mithridates III. Ariobarzanes II. and Mithridates IV. the immediate ſucceſſors of Mithridates II. nothing remarkable happened. But Mithridates V. made war on the inhabitants of Sinope, a city on the coaſt of Paphlagonia. He made himſelf maſter of all the adjacent places; but finding the whole peninſula, on which Sinope itſelf ſtood, well fortified and garriſoned, not only by the inhabitants, but by their allies the Rhodians, he abandoned the enterpriſe. He afterwards proved a great friend to the Rhodians, and aſſiſted them with money to repair the loſſes they had ſuſtained by an earthquake. He entered alſo into a ſtrict alliance with Antiochus the Great, who married one of his daughters named *Laodice*.

5 arnacesI. ers with Ro- ns.

After the death of Mithridates V. his ſon Pharnaces I. attacking the city of Sinope, unexpectedly took it by ſtorm. On this the Rhodians ſent ambaſſadors to Rome, complaining of the behaviour of the king of Pontus; but Pharnaces was ſo far from being intimidated by their threats, that he invaded the territories of Eumenes their great ally. The latter ſent ambaſſadors to Rome, and entered into an alliance with Ariarathes king of Cappadocia. Pharnaces, in his turn, ſent ambaſſadors to Rome, complaining of Eumenes and Ariarathes; upon which ſome Romans were ſent into Aſia to inquire into the ſtate of matters. Theſe found Eumenes and his aſſociates willing to accommodate the difference, but Pharnaces in a quite oppoſite diſpoſition, which they accordingly reported at Rome.

In the mean time a war was commenced between Eumenes and Pharnaces; but the latter, being diſappointed of aſſiſtance from Seleucus king of Syria, whom the Romans would not allow to join him, was at laſt forced to ſue for peace; which was granted him upon the following conditions: That he ſhould forthwith withdraw his forces from Galatia, and diſannul all engagements and alliances with the inhabitants of that country; that he ſhould in like manner evacuate Paphlagonia, and ſend back ſuch as he had from thence carried into ſlavery; that he ſhould reſtore to Ariarathes all the places which he had taken during the war, the hoſtages of both kings, all their priſoners without ranſom, and moreover ſhould deliver up to them ſuch of their ſubjects as from the firſt breaking out of the war had fled to him; that he ſhould return to Morzias, a petty king in theſe parts, and to Ariarathes, 900 talents which he had ſeized in the war, and pay down 300 more to Eumenes as a fine for invading his dominions without provocation. Mithridates, king of Armenia, having in this war joined Pharnaces, was, by the articles of the treaty, obliged to pay 300 talents to Ariarathes for having aſſiſted his enemy contrary to an alliance at that time ſubſiſting between them. Soon after Pharnaces died, and left the kingdom to his ſon Mithridates VI. more weakened by this peace than by the moſt deſtructive war.

6 cludes ſt diſ- ntage- peace.

7 His ſon enters into alliance with the Romans.

The new king entered into an alliance with the Romans, and proved ſuch a faithful friend, that he was rewarded by the ſenate with Phrygia Major, and honoured with the title of the friend and ally of the people of Rome. After a long and proſperous reign, he was murdered by ſome of his intimate acquaintance, and was ſucceeded by his ſon Mithridates VII. ſurnamed the *Great*.

8 Mithridates the Great a cruel prince.

The new prince, though not exceeding 13 years of age, began his reign with moſt inhuman acts of cruelty to his mother and neareſt relations. His father, by his laſt will, had appointed him and his mother joint heirs to the kingdom; but he, claiming the whole, threw her into priſon, where ſhe ſoon died through the hard uſage ſhe met with. Thoſe to whom the care of his education was committed, obſerving him to be of a cruel and unruly temper, made various attempts on his life, but could never effect their deſign, as the king was always on his guard, and armed, in that tender age, againſt all kind of treachery, without ſhowing the leaſt diffidence.

9 His extraordinary qualities.

In his youth Mithridates took care to inure himſelf to hardſhips, paſſing whole months in the open air, employed in the exerciſe of hunting, and often taking his reſt amidſt the frozen ſnow. When he came of age, he married his ſiſter named *Laodice*, by whom he had a ſon named *Pharnaces*. After this he took a journey through many different kingdoms of Aſia, having nothing leſs in view than the whole continent. He learned their different languages, of which he is ſaid to have ſpoken 22; took an eſtimate of their ſtrength; and above all viewed narrowly their ſtrong holds and fortified towns. In this journey he ſpent three years; during which time, a report being ſpread abroad that he was dead, his wife Laodice had a criminal converſation with one of the lords of her court, and had a ſon by him. When her huſband returned, ſhe preſented him with a poiſoned bowl; but Mithridates had accuſtomed himſelf to take poiſon from his infancy, ſo that it had now no other effect than to haſten the deſtruction of his wife, which very ſoon took place, together with all thoſe who had been any way acceſſory to her diſloyalty and incontinence.

The king now began to put in execution his ſchemes of conqueſt. However, he certainly took the wrong method by attacking firſt thoſe nations which were im-

 mediately

Pontus.

10 Conquers ſeveral countries.

mediately under the protection of Rome, and thus at once provoking that powerful people to fall upon him. He began with Paphlagonia, which the Romans had declared a free ſtate. This country he eaſily reduced, and divided between himſelf and Nicomedes king of Bithynia, at that time his ally. The Romans remonſtrated; but Mithridates, inſtead of paying any regard to their remonſtrances, invaded Galatia, which was immediately under their protection. This he alſo reduced, and then turned his eyes on Cappadocia. But as the kingdom of Cappadocia was at that time held by Ariarathes, who was a great favourite of the Romans, and married to the ſiſter of Mithridates, the latter hired an

11 Cauſes the king of Cappadocia to be murdered.

aſſaſſin to diſpatch Ariarathes, after which he thought he might ſucceed better in his deſigns. After the death of Ariarathes, Cappadocia was invaded by Nicomedes king of Bithynia, who drove out the ſon, and married the widow of Ariarathes. This gave Mithridates a plauſible pretence for invading Cappadocia; which he inſtantly did, and drove Nicomedes quite out of the country. Thus Mithridates gained conſiderable reputation, not only as a warrior, but as a juſt and good-natured prince; for as it was not known that he had any hand in the murder of Ariarathes, every one imagined that he had undertaken the war againſt Nicomedes, merely to revenge the quarrel of his nephew, and to reſtore him to his right. To keep up the farce a little longer, Mithridates actually withdrew his troops out of the country, and left the young prince maſter of the kingdom. In a ſhort time, however, he began to preſs the young king of Cappadocia to recal the aſſaſſin Gordius, who had murdered his father: but this the king of Cappadocia refuſed with indignation; and Mithridates, being determined on a quarrel at all events, took the field with an army of 80,000 foot, 10,000 horſe, and 600 chariots armed with ſcythes. With this force he imagined he ſhould carry all before him: but finding the king of Cappadocia ready to oppoſe him with a force no way inferior to his own, he had recourſe to

12 Aſſaſſinates his own nephew.

treachery; and inviting his nephew to a conference, ſtabbed him, in the ſight of both armies, with a dagger which he had concealed in the plaits of his garment. This barbarous and unexpected piece of treachery had ſuch an effect on the Cappadocians that they threw down their arms, and ſuffered Mithridates, without oppoſition, to ſeize upon all their ſtrong holds. He reſigned the kingdom, however, to his ſon, a child of eight years of age. The care of the young prince, and of the whole kingdom, he committed to Gordius; but the Cappadocians, diſdaining to be ruled by ſuch a ſcandalous aſſaſſin, placed on the throne the brother of Ariarathes, who had kept himſelf concealed in ſome part of Aſia. His reign, however, was of ſhort duration; he being ſoon after driven out by Mithridates, and the Cappadocians again reduced. The unhappy prince died of grief; and in him ended the family of Pharnaces, who had ruled Cappadocia from the time of Cyrus the Great.

13 Nicomedes king of Bithynia attempts to deceive the Romans.

Nicomedes, king of Bithynia, being now greatly afraid of Mithridates, and ſuppoſing that his own dominions would next fall a prey to the ambitious conqueror, ſuborned a youth of a comely and majeſtic aſpect to pretend that he was a third ſon of Ariarathes, to go to Rome, and demand the kingdom of Cappadocia as his juſt right. He was received by the ſenate with the greateſt kindneſs, and Laodice the wife of Nicomedes even confirmed the deceit by her oath. But in the mean time Mithridates having got intelligence of the plot, ſent notice of it by Gordius to the Romans, ſo that the impoſture was ſoon known at Rome alſo. The conſequence of this was, that the ſenate commanded Mithridates to relinquiſh Cappadocia, and Nicomedes that part of Paphlagonia which he poſſeſſed; declaring both theſe countries free. The Cappadocians proteſted that they could not live without a king; upon which they were allowed to chooſe one of their own nation. Mithridates uſed all his intereſt in favour of Gordius; but he being excluded by the Romans, one Ariobarzanes was choſen by the majority of votes.

Pontus

14 The dec exposed Mithrid tes.

15 Ariobar zanes ſe tled on throne Cappad by the R mans, b driven o by Mith dates,

To enforce this election, Sylla was ſent into Cappadocia. He had the character of an ambaſſador, but the real intent of his coming was to diſappoint the ambitious deſigns of Mithridates. With an handful of forces he defeated a numerous army of Cappadocians and Armenians commanded by Gordius, and ſettled Ariobarzanes on the throne. But no ſooner was Sylla gone than Mithridates ſtirred up Tigranes king of Armenia againſt Ariobarzanes, who, without making any reſiſtance, fled to Rome, and Tigranes reſtored the kingdom to Ariarathes the ſon of Mithridates. At the ſame time died the king of Bithynia; upon which Mithridates immediately invaded that country, and drove out Nicomedes the natural ſon of the late king. But the expelled prince, having fled to Rome, and being aſſiſted by that powerful republic, the king of Pontus was ſoon obliged to abandon Bithynia and Cappadocia.

16 Who en gages in war wit the Ro mans.

The Romans now being exceedingly jealous of the power and ambition of Mithridates, reſolved to humble him at all events. For this purpoſe they ſent ambaſſadors to the kings of Bithynia and Cappadocia, deſiring them to make frequent inroads into the neighbouring territories of Mithridates, and behave there as they pleaſed; aſſuring them of powerful aſſiſtance in caſe they ſhould have occaſion. Ariobarzanes could not by any means be induced to provoke ſo powerful a neighbour; but Nicomedes being induced, partly by promiſes and partly by menaces, to comply, entered Pontus, where he laid waſte whole provinces with fire and ſword. Mithridates complained to the Roman legates: but they replied, that he himſelf had been the firſt aggreſſor; that Nicomedes had only paid him in his own coin, and that they would not allow him to

17 Defeats riobarz and Al inius,

hurt their friend and ally. Upon this Mithridates, entering Cappadocia with a numerous army, put to flight the united forces of Ariobarzanes and Altinius the Roman legate; thus making himſelf once more maſter of this kingdom. In the mean time he ſent ambaſſadors to Rome, complaining of the proceedings of Nicomedes: but his ambaſſadors met with a very indifferent reception; being enjoined to tell their maſter, that he muſt either reſtore the kingdom of Cappadocia to Ariobarzanes, and make peace with Nicomedes, or be accounted an enemy of the Roman people. With this anſwer they were commanded to depart the city that very day, and told that no more ambaſſadors could be admitted till ſuch time as their commands were obeyed.

In the mean time both parties prepared for war. The Roman legates in Aſia drew together all the forces they could muſter in Bithynia, Cappadocia, Paphlagonia, and Galatia; and, being joined by Caſſius governor of

ntus. of Aſia, took the field againſt Mithridates in the year 89 B. C. They divided their army into ſeveral ſmall bodies: Caſſius encamped on the confines of Bithynia and Galatia; Manius Aquilius with his body poſſeſſed himſelf of the avenues leading from Pontus into Bithynia; Quintus Oppius ſecured the entrance into Cappadocia; and the admirals Minucius Rufus and C. Popilius lay with a fleet of 300 ſail at Byzantium, to prevent the enemy from entering the Euxine ſea. Each of the generals had under his command an army of 40,000 men; beſides a body of 50,000 foot and 6000 horſe brought to their aſſiſtance by Nicomedes.

On the other hand, Mithridates having invited ſeveral of the neighbouring nations to join him, collected an army of 250,000 foot, 50,000 horſe, 130 chariots armed with ſcythes; beſides 300 ſhips and 100 galleys.

18
d Nicodes and ius Alius

Part of this force he detached againſt Nicomedes; and utterly defeated him, though much ſuperior in number, as he was taking poſſeſſion of an advantageous poſt by order of Caſſius. Another part he detached againſt Manius Aquilius, whom he alſo defeated with the loſs of 10,000 killed on the ſpot, and 3000 taken priſoners; on which the other Roman generals abandoned their poſts, the fleet alſo diſperſed, and moſt of the ſhips were either taken or ſunk by the admirals of Mithridates.

19
er-runs a Mi-

The king of Pontus now reſolving to improve the opportunity, and drive the Romans entirely out of Aſia, over-ran all Phrygia, Myſia, Aſia Proper, Caria, Lycia, Pamphylia, Paphlagonia, and Bithynia, with all the reſt of the countries which had either belonged to or ſided with the Romans, as far as Ionia. He was received everywhere with the greateſt demonſtrations of joy; the inhabitants flocking to him in white garments, and calling him their father, deliverer, their god, and the great and ſole lord of all Aſia. What gained him the affections of the people was his kind uſage to the priſoners he had taken in the two engagements above-mentioned; for he not only ſent them all home without ranſom, but furniſhed them with plenty of proviſions, and money ſufficient to defray their expences by the way. Ambaſſadors flocked to him from all parts; and among others, from Laodicea on the Lycus, to whom the king promiſed his protection, provided they delivered up to him Q. Oppius governor of Pamphylia, who had fled thither for protection. This requeſt was readily complied with; Oppius was ſent to him in chains, with lictors walking before him in deriſion of the Roman pride and oſtentation. Mithridates was overjoyed to ſee a Roman general and proconſul in his power; and his joy was ſoon after increaſed by the arrival of Manius Aquilius, whom the Leſbians, revolting from the Romans, ſent to him in fetters, together with many other Romans of diſtinction who had taken ſhelter among them. As he had been the chief author of the war, Mithridates led him about with him wherever he went, either bound on an aſs, or on foot coupled with one Baſtarnes a public malefactor, compelling him to proclaim to the crowds who came to ſee him, that he

20
ts Aqui-s to ath.

was Manius Aquilius the Roman legate. When he came to Pergamus, he cauſed him firſt to be publicly whipped, then to be put on the rack, and laſtly melted gold to be poured down his throat.

Mithridates being now looked upon as invincible, all the free cities of Aſia received him as their ſovereign, contributing large ſums towards the defraying the expences of the war; by which means he became poſſeſſed of ſuch treaſures as enabled him to keep ſeveral numerous armies in the field for five years without levying any taxes on his ſubjects. As many Roman citizens were diſperſed in the provinces which Mithridates had ſubdued, he conſidered theſe as ſo many ſpies who would not fail to ſend an account of his proceedings to Rome: 21

Cruelty maſſacres all the Romans in Aſia.

for which reaſon he reſolved to cut them all off at once by a general maſſacre; which barbarous policy, it is ſaid, had never been heard of till his time, but has been ſince practiſed by other nations. He diſpatched private letters to all the governors and magiſtrates of the cities where the Romans reſided, enjoining them on pain of death, and the entire deſtruction of their country, to cauſe all the Italian race, women and children not excepted, to be murdered on the 30th day from the date of his letters, and to let their bodies lie unburied in the open fields. One moiety of their goods was to be forfeited to the king, and the other beſtowed as a reward on the aſſaſſins. Whatever ſlave murdered his maſter was to receive his liberty, and one half of the debt was to be remitted to the debtor that ſhould kill his creditor. Whoever concealed an Italian, under any pretence whatever, was to be puniſhed with immediate death. On the fatal day, all the gates of the cities being ſhut, and the avenues kept with ſoldiers, the king's orders were proclaimed, which cauſed an univerſal horror, not only among the unhappy victims themſelves, but among thoſe who had any feelings of humanity, at ſeeing themſelves obliged either to betray and murder their innocent gueſts, friends, and relations, or to become liable to a cruel death. However, as moſt of the Aſiatics bore a mortal hatred to the Romans, and were moreover animated by the promiſe of an ample reward, the orders were without delay put in execution. The inhabitants of Epheſus, where Mithridates then reſided, dragged ſuch as had taken ſanctuary in the temple of Diana from the very ſtatue of the goddeſs, and put them to the ſword. The Pergamenians diſcharged ſhowers of darts upon them as they embraced the ſtatues in the temple of Eſculapius. At Adramyttium in Myſia many were murdered in the water, while they were attempting, with their children on their backs, to ſwim over to the iſland of Leſbos. The Caunians, who not long before had been delivered from the yoke of the Rhodians, and reſtored to their ancient privileges, excelled all the reſt in cruelty: for, as if they had apoſtatiſed from human nature, they took pleaſure in tormenting and butchering the innocent children before their mothers eyes; ſome of them running diſtracted, and others dying with grief at a ſight which nature could not bear. The Trallians were the only people on the continent who would not have the cruelty to imbrue their hands in the blood of the innocent Italians. However, as the king's orders were peremptory, they hired one Theophilus a Paphlagonian to diſpatch the few Romans that lived among them. He, having ſhut them all up together in the temple of Concord, firſt cut off their hands as they embraced the ſtatues of the gods, and then hacked them in pieces. Many Romans were ſaved on the floating iſlands of Lydia called *Calaminæ*, where they concealed themſelves till ſuch time as they found an opportunity of eſcaping out of Aſia. Nevertheleſs,

Pontus.

theleſs, according to Plutarch and Dion, 150,000 Roman citizens were maſſacred on that day; but, according to others, only 80,000.

Mithridates having now got rid of thoſe whom he was in dread of on the continent, embarked great part of his forces in order to reduce the iſlands of the Archipelago. At Cos he was gladly received, and had delivered up to him the young Alexander, ſon of Alexander king of Egypt, who being driven out of that country, was killed by Chareas a ſea-captain as he was retiring in a ſmall veſſel to Cyprus. With the young prince, they put into the king's hands vaſt ſums of money, with all the golden veſſels and jewels, to an immenſe value, which his grandmother Cleopatra had been amaſſing for many years. To the young prince Mithridates gave an education ſuitable for a king's ſon, but kept the treaſures to himſelf. Here likewiſe he found 800 talents in ready money, which, at the firſt breaking out of the war, had been depoſited by the Jews of Aſia, and were deſigned for the temple of Jeruſalem.

22 Reduces the iſland of Cos,

23 But fails in his attempt upon Rhodes.

From Cos Mithridates ſteered his courſe for Rhodes, where at that time all the Romans who had eſcaped the maſſacre above-mentioned found a ſanctuary, and, amongſt others, L. Caſſius the proconſul. The Rhodians, however, being very expert in maritime affairs, Mithridates did not think proper to venture an engagement. As the enemy's fleet advanced, therefore, he retired; but ſix of the Rhodian ſhips coming up with 25 of his, a ſharp action enſued, in which the Rhodians ſunk two of the king's ſhips, and put the reſt to flight. In this encounter, though Mithridates had never ſeen a ſea-fight before, he behaved with great intrepidity; but one of the ſhips of his own ſquadron falling foul of that which carried him, he was very near being taken priſoner. From this time forth he abhorred the ſea, and took an averſion to all the Chians, becauſe the pilot of that ſhip was a Chian. However, he again appeared before the iſland; but was forced anew to leave it with diſgrace, and to give over all thoughts of reducing it.

24 His generals reduce all Greece.

Mithridates now retired into Aſia, with a deſign to ſettle the civil government of the countries which he had conquered, committing the care of the war to his generals. Archelaus, his generaliſſimo, was ſent into Greece with an army of 120,000 men; where, by treachery, he made himſelf maſter of Athens, and either put to the ſword or ſent to Mithridates all thoſe who favoured or were ſuſpected to favour the Romans. From Athens he diſpatched parties to reduce the neighbouring caſtles and the iſland of Delos, which they did accordingly; but Orobius, a Roman general, hearing that the enemy kept no guards, but paſſed their time in carouſing and debauchery, fell upon them unexpectedly, and cut off the whole party, except Apellicon the commander.

In the mean time, Metrophanes, another of the king's generals, entering Eubœa, laid waſte the whole country, exerting his rage chiefly againſt the cities of Demetrias and Magneſia, which refuſed to open their gates to him. But as he was ſailing off with a great booty, Bryttius, the prætor or governor of Macedonia, coming up with him, ſunk ſome of his ſhips, and took others, putting all the priſoners to the ſword. Mithridates, upon the news of this loſs, ſent his ſon Ariarathes with a powerful army to invade Macedonia; which he ſoon reduced, together with the kingdom of Thrace, driving the Romans everywhere before him. The generals whom he ſent into other quarters were no leſs ſucceſsful; ſo that Mithridates had, according to Aulus Gellius, 25 different nations who paid him homage. The ſame author adds, that he was ſkilled in every one of their various languages, ſo that he could converſe with the natives without an interpreter. Among theſe nations we find the Roxani, now the Ruſſians or Muſcovites, whom Deiphontus, one of the king's generals, brought under ſubjection, after having ſlain in an engagement 50,000 of the barbarians.

All this time the Romans had been too much taken up with their own domeſtic quarrels to take ſuch effectual meaſures as they otherwiſe would have done for checking the progreſs of Mithridates. But at laſt, having received certain advice that the king deſigned to invade Italy, and that he had even been ſolicited to do ſo by ſome of the revolted Italians, they ſent againſt him Lucius Sylla, who had already given ſufficient proofs of his courage, conduct, and experience in war. He had with him only five legions and a few cohorts. With this inconſiderable force he landed in Attica, and in a ſhort time made himſelf maſter of the capital; Archelaus not daring, or, according to others, through treachery, not caring, to engage him. As Sylla had but a few frigates, he ſent Lucullus to the iſland of Rhodes, with orders to the Rhodians to join him with their fleet. The undertaking was very dangerous, as the king's fleet in a manner covered the ſea. However, Lucullus, deſpiſing all danger, ventured out, and ſailed, without meeting with any perverſe accident, to Syria, Egypt, Libya, and Cyprus; from whence he returned with ſuch ſupplies of ſhips and experienced mariners, as enabled Sylla, after their conjunction with the Rhodians, to act offenſively by ſea alſo. Archelaus now diſpatched meſſengers to Taxiles, who commanded in Thrace and Macedon, deſiring him to join him with all his forces; which the other readily did, and between both muſtered an army of 120,000 men. Sylla met them near Cheronæa with only 15,000 foot and 1500 horſe; but gave them a moſt dreadful overthrow, no fewer than 110,000 of the Aſiatics being ſlaughtered, while the Romans loſt only 12 men.

25 Sylla ſent againſt him,

26 Who totally defeats his generals in Greece.

This ſucceſs having raiſed envy and jealouſy againſt Sylla in Rome, the ſenate ſent Lucius Valerius Flaccus, the conſul of that year, with two legions into Aſia, in appearance to attack Mithridates on that ſide, but with private inſtructions to fall upon Sylla himſelf, if they found him diſaffected to the ſenate. As Flaccus was a man of no experience in war, C. Fimbria, a ſenator of great repute among the ſoldiery, was appointed to attend him with the character of legate and lieutenant-general. Sylla was at that time in Bœotia; but, hearing what had happened at Rome, he marched with all expedition into Theſſaly, with a deſign to meet Flaccus, who, he expected, was to land in that province. But no ſooner had he left Bœotia, than the country was over-run by an army of Aſiatics, under the command of Dorylaus the king's chief favourite. On this advice Sylla returned into Bœotia, where he gained two ſignal victories, which put an end to the war in Greece. In the firſt of theſe Dorylaus loſt 150,000 of his men according to ſome, or 200,000 according to others; and in the next all the reſt. In this laſt engagement 20,000

27 Flaccus and Fimbria ſent into Aſia.

28 Sylla gains two other victories in Greece.

20,000 were driven into a river, where they all periſhed; an equal number were purſued into a marſh, and entirely cut off; the reſt were killed in the heat of battle, the Romans giving no quarter to men who had treated their fellow-citizens after ſuch a barbarous manner in Aſia. Plutarch tells us, that the marſhes were dyed with blood; that the courſe of the river was ſtopped by the dead bodies; and that even in his time, that is, near 200 years after, a great number of bows, helmets, coats of mail, and ſwords, were found buried in the mud. Archelaus, who had joined Dorylaus with a body of 10,000 men a few days before the battle, lay three days ſtripped among the ſlain till he found a ſmall veſſel which carried him to Eubœa, where he gathered what forces he could, but was never again able to appear in the field. Indeed Livy tells us, that Archelaus betrayed the king's cauſe; and Aurelius Victor, that the king's fleet was intercepted by Sylla through the treachery of Archelaus: adding, that there was a good underſtanding between the two commanders, as was plain from Sylla's beſtowing upon Archelaus 10,000 acres of land near the city of Chalcis in Eubœa. Strabo alſo informs us, that Archelaus was afterwards greatly eſteemed and careſſed by Sylla and the ſenate; but Sylla himſelf in his commentaries, and Dio, endeavour to clear Archelaus from all ſuſpicion of treachery.

In the mean time, Sylla having given up Bœotia to be plundered by his ſoldiers, marched into Theſſaly, where he took up his winter-quarters, cauſed his old ſhips to be refitted and ſeveral new ones built, in order to paſs over into Aſia in the beginning of the ſpring, that he might drive from thence not only Mithridates, but his rival Flaccus alſo, whom the ſenate, out of oppoſition to him, had appointed governor of that province. But before he arrived, ſome differences having ariſen between Flaccus and Fimbria, the latter was by
29
the conſul deprived of his command. Upon this Fimbria, having gained over the ſoldiery to his ſide, made war on the conſul, took him priſoner, put him to death, and aſſumed the command of all the Roman forces in Aſia. In this ſtation he behaved with the greateſt cruelty, inſomuch that his name became more odious than even that of Mithridates itſelf. This hatred the king of Pontus endeavoured to improve to his own advantage; and therefore commanded his ſon, by name alſo *Mithridates*, to join Taxiles, Diophantes, and Menander, three of his moſt experienced commanders, to return at the head of a numerous army into Aſia; not doubting but the inhabitants, thus haraſſed by Fimbria, would ſhake off the Roman yoke when they ſaw ſuch a powerful army in the field ready to protect them. But Fimbria, diſtruſting the Aſiatics, marched out to
30
meet the enemy, and offered them battle before they entered the province. As the king's army was greatly ſuperior to the Romans in number, the latter ſuffered greatly in the engagement, but held out till night parted them, when they withdrew to the oppoſite ſide of a river, which was at a ſmall diſtance from the field of battle. Here they deſigned to intrench themſelves: but in the mean time a violent ſtorm ariſing, Fimbria laid hold of that opportunity to repaſs the river and ſurpriſe the enemy: of whom he made ſuch havock as they lay in their tents, that only the commanders and
31
ſome few troops of horſe eſcaped. Among theſe was the king's ſon; who, attended by a few horſe, got ſafe to Pergamus, where his father reſided. But Fimbria, purſuing him night and day without intermiſſion, entered Pergamus ſword in hand; and hearing that both Mithridates and his ſon had fled from thence a few hours before, he continued his purſuit, and would have taken the king himſelf, had he not entered Pitane with a conſiderable body of horſe. The place was cloſely inveſted by Fimbria; but as he had no ſhips to block it up by ſea alſo, he ſent a meſſenger to Lucullus, who commanded the Roman navy in Aſia, intreating him, as he tendered the welfare of the republic, to make what haſte he could to Pitane, and aſſiſt him in taking 32
the moſt inveterate enemy the Romans had. But Lucullus, preferring the gratification of a private pique to the good of his country, refuſed to come: and thus allowed the fleet of Mithridates to carry him in ſafety to Mitylene. Who is ſuffered by Lucullus to eſcape.

Soon after the king's departure, Fimbria took Pitane by ſtorm, and reduced moſt of the cities of Aſia, particularly Troy, which he alſo took by ſtorm in eleven days, and put moſt of the inhabitants to the ſword, becauſe they had ſent an embaſſy to Sylla, offering to ſubmit to him rather than to Fimbria.—To add to the misfortunes of Mithridates, his fleet was entirely defeated in two engagements by Lucullus; ſo that he began to be weary of the war, and therefore deſired Archelaus to conclude a peace upon as honourable terms 33
as he could. The king himſelf had afterwards alſo a conference with Sylla, and a peace was concluded in 85 B. C. on the following terms, viz. That Mithridates ſhould relinquiſh all his conqueſts, and content himſelf with his paternal dominions, which were confined within the limits of Pontus: that he ſhould immediately reſign Bithynia to Nicomedes, and Cappadocia to Ariobarzanes, and releaſe without ranſom all the priſoners he had taken during the war: that he ſhould pay to the Romans 2000, or as others will have it 3000, talents, and deliver up to Sylla 80 ſhips with all their arms and ammunition, and 500 archers; and laſtly, that he ſhould not moleſt ſuch cities or perſons as had during the war revolted from him and ſided with the Romans. Peace concluded.

Sylla, having thus concluded the war with great glory to himſelf and advantage to the republic, turned his army againſt Fimbria; but the latter, finding himſelf in no condition to oppoſe his rival by force, had recourſe to treachery, and attempted to get Sylla murdered. The plot miſcarried, and Fimbria put an end to his own life; upon which Sylla, having now an uncontrouled power in Aſia, declared the Chians, Rhodians, Lycians, Magneſians, and Trojans, free, and friends of the people of Rome, by way of reward for their having ſided with the Romans: but on the other cities he laid heavy fines; condemning them in one year to pay 20,000 talents, and quartering his ſoldiers in the houſes of thoſe who had ſhown diſaffection to the Romans. Each private man was to receive of his landlord 16 drachmas a-day, and each officer 50; and beſides, both were to be ſupplied with proviſions, not only for themſelves, but for ſuch of their friends as they thought proper to invite. By theſe impoſitions moſt of the people of Aſia were reduced to beggary; eſpecially the inhabitants of Epheſus, who had above all others ſhown their hatred to the Romans. Sylla then, having collected immenſe treaſure, ſet ſail for Italy; leaving behind him Lucullus

with

Pontus. with the character of *quæstor*, and Muræna with that of *prætor*.

The two legions which Fimbria had commanded were given to Muræna, because Sylla suspected them of an inclination to the faction of Marius, whose party he was going to crush at Rome.

34 Mithridates reduces the nations which had revolted from him.

Mithridates in the mean time no sooner returned into Pontus, than he set about the reduction of those nations which had revolted from him during the war. He began with the Colchi; who immediately submitted, upon condition that Mithridates would give his son for a king over them. This was complied with; but the old king had thenceforward a jealousy of his son, and therefore first imprisoned and then put him to death. Soon after this, the king having made great preparations under pretence of reducing the Bosphori, a warlike nation who had revolted from him, the Romans began to be jealous. Their jealousy was further increased by Archelaus, who fled to them, and assured them that the preparations of Mithridates were not at all designed against the Bosphori. On hearing this, Muræna invaded Pontus without any farther provocation. The king put him in mind of the articles of peace concluded with Sylla: but Muræna replied that he knew of no such articles; for Sylla had set nothing down in writing, but contented himself with the execution of what had been agreed upon. Having given this answer, the Roman general began to lay waste and plunder the country, without sparing even the treasures or temples consecrated to the gods. Having put all to fire and sword on the frontiers of Pontus towards Cappadocia, he passed the river Halys, and on that side possessed himself of 400 villages without opposition; for Mithridates was unwilling to commit any hostilities before the return of an ambassador whom he had sent to Rome to complain of the conduct of Muræna. At last the ambassador returned, and with him one Callidius; who, in public assembly, commanded Muræna to forbear molesting a friend and ally of the Roman people; but afterwards, calling him aside, he had a private conference with him, in which it is supposed, as he brought no decree of the senate, that he encouraged him to pursue the war. Whatever might be in this, it is certain that Muræna still continued to practise the same hostilities, and even made an attempt on Sinope, where the king resided and the royal treasures were kept. But as the town was well fortified, he was forced to retire with some loss. In the mean time Mithridates himself taking the field, appeared at the head of a powerful army, drove the Romans out of their camp, and forced them with great slaughter to save themselves over the mountains into Phrygia; which sudden victory again induced many cities to join Mithridates, and gave him an opportunity once more of driving the Romans out of Cappadocia.

35 The Romans invade his territories without provocation,

36 But are defeated.

In the mean time, Sylla, being created dictator at Rome, sent a messenger to Muræna, charging him in his name not to molest Mithridates, whom he had honoured with the title of a friend and ally of Rome. Muræna did not think proper to disregard this message; and therefore immediately abandoned all the places he had seized, and Mithridates again renounced Cappadocia, giving his own son as an hostage of his fidelity. Being then at leisure to pursue his other plans, Mithridates fell upon the Bosphori; and, having soon subdued them, appointed Machares one of his sons king of the country. But leading his army from thence against the Achæans, a people bordering on the Colchi, and originally descended from the Greeks, who returning from Troy had mistaken their way into Greece and settled there, he was defeated with the loss of three-fourths of his men. On his return to Pontus, however, he recruited his army, and made vast preparations to invade them anew; but in the mean time, hearing of Sylla's death, he came to the imprudent resolution of entering into a second war with the Romans. Having therefore induced his son-in-law Tigranes, king of Armenia, to invade Cappadocia, he himself entered Paphlagonia at the head of 120,000 foot disciplined after the Roman manner, 16,000 horse, and 100 chariots armed with scythes. This country readily submitted; after which the king marched into Bithynia, which also submitted without opposition; the province of Asia followed the example of the rest; for these countries being oppressed with exorbitant taxes, looked upon him as their deliverer. In entering the cities of Asia, he caused M. Marius or Varius, whom Sertorius had sent him out of Spain to discipline his troops, walk before him with the ensigns of consular dignity as if he was the chief magistrate; the king following as one of his attendants. He made several cities free; but at the same time acquainted the inhabitants, that they were indebted to Sertorius for their liberty; and thus, by the connivance of that general, many cities revolted from the Romans without knowing that they had done so. But in the mean time Julius Cæsar, being at that time at Rhodes, whither he had gone to study oratory, and hearing what havock the king's officers made in the adjacent countries, he collected what troops he could, and falling unexpectedly upon them, drove them quite out of the province of Asia.

37 Engages in a new war with the Romans.

38 Lucullus and Cotta sent against him.

The Roman senate, now finding a war unavoidable, appointed Lucullus to manage it. The other consul Cotta, having solicited an employment in this war, was sent with a fleet to guard the Propontis and defend Bithynia. Lucullus having raised one legion in Italy, passed over with it into Asia, where he was joined by four others, two of which, as they had served under Fimbria, proved at first very mutinous and refractory; nor were the other two much better, having been immersed in the Asiatic luxuries. The disciplining of these troops took up a considerable time, which was prejudicial to the Roman affairs; for almost all the Asiatics were ready to revolt, and Mithridates was making the greatest preparations. One of his armies was ordered to march into Cappadocia, under the command of Diophantus Matharus, in order to oppose Lucullus if he should attempt to enter Pontus on that side; another, commanded by Mithridates in person, consisted of 150,000 foot, 12,000 horse, and 100 chariots armed with scythes; a third army, commanded by Marius and Eumachus, two generals of great experience in war, was encamped in the neighbourhood of Heraclea in Pontus.

39 Mithridates is at first successful.

The beginning of the war proved favourable to Mithridates. Cotta being desired by Lucullus to keep his fleet within the harbour, as being inferior to that of Mithridates, resolved to take the first opportunity of fighting the king by land, not doubting of an easy victory. Having for this purpose collected all the forces he could, Cotta dispatched his legate, P. Rutilius, with a

a conſiderable body to obſerve the motions of the enemy. This commander being met by Marius and Eumachus, an engagement enſued, in which the Romans were defeated, and the greateſt part of them, together with their commander, cut in pieces. The ſame misfortune befel ſeveral other officers of diſtinction ſent out to oppoſe Mithridates; who, being elated with ſucceſs, ordered his admiral to ſail into the very harbour, and fire the Roman fleet. This was accordingly performed without the leaſt oppoſition from Cotta; and 60 ſhips were taken, ſunk, or burnt, on that occaſion.

Theſe victories having increaſed the rebellious diſpoſition of the Aſiatics, made Lucullus haſten his march in order to ſtop the progreſs of the enemy. But finding the king's army much more numerous than he expected, he thought proper to decline an engagement. However, ſeveral ſkirmiſhes happened, in which the Romans had always ſo much the advantage, that they became impatient for a general engagement. But Lucullus did not at this time chooſe to run ſo great a riſk; and therefore Mithridates, ſeeing he could not force the Romans to a battle, decamped in the night-time, and by day-break reached Cyzicum, a moſt important city, and greatly attached to the Romans. Lucullus purſued him; and, falling on his rear, killed 10,000, and took 13,000 priſoners. After this, the Roman general, by a manœuvre, gained an important paſs, which enabled him to cut off all communication between the army of Mithridates and the neighbouring country. The king, ſeeing himſelf thus in danger of famine, redoubled his efforts to gain the city; but finding that he could not batter down the walls, he reſolved to undermine them. In this alſo he was unſucceſsful; the beſieged ſunk countermines, and had very near taken the king himſelf in one of his own mines. In the mean time, winter coming on, the army of Mithridates was ſo diſtreſſed for want of proviſions, that many died of hunger, while the ſurvivors were forced to feed on the fleſh of their dead companions. The famine was followed by a plague; which deſtroyed ſuch numbers, that Mithridates was obliged to think of a retreat; and even this was become very dangerous. However, he laid hold of the opportunity when Lucullus went away to beſiege a neighbouring caſtle, and ſent off the greateſt part of his cavalry in the night; ordering them not to halt till they were out of the reach of the enemy. But Lucullus having got intelligence of their march, ſuddenly returned, and purſued them ſo cloſe, that he came up with them as they were paſſing a river, took 600 horſe, all their beaſts of burden, 15,000 men, and put the reſt to the ſword. On his return he fell in with Ariſtonicus the king's admiral, whom he took, juſt as he was ready to ſail with a large ſum of money deſigned to bribe the Roman army. In the mean time Mithridates, finding himſelf reduced to the laſt extremity, embarked in the night-time with the greateſt part of the forces, while Marius and Eumachus, with 30,000 men, made the beſt of their way to Lampſacus. But being cloſely purſued by the Romans, they were overtaken at the river Æſopus, which at that time was not fordable, by reaſon of its having been ſwelled by heavy rains. Twenty thouſand were killed on the ſpot; nor could a ſingle man have eſcaped, had not the Aſiatics ſcattered great quantities of gold and ſilver in the way, that the march of the Romans might be retarded by their ſtopping to gather it up. Lucullus on his return entered Cyzicum amidſt the acclamations of the citizens; who afterwards inſtituted public ſports in honour of him, which they called *Lucullea*. The city was declared free, and all the privileges, exemptions, and immunities, beſtowed upon the citizens which were enjoyed by the inhabitants of Rome itſelf.

Pontus.

42
Lucullus gains a great victory at ſea.

From Cyzicum, Lucullus marched along the coaſt of the Helleſpont till he came to Troas; where he equipped his fleet, and put to ſea in queſt of Marius, Alexander, and Dionyſius, three of the king's generals, who had a fleet of 50 ſhips, with 10,000 land-forces on board. Lucullus came up with them near the iſland of Lemnos, took 32 of their ſhips, and put a great number of their land-forces to the ſword. The day after the engagement the three generals were diſcovered in a cave where they had concealed themſelves, and dragged from thence to Lucullus; who, after having ſeverely upbraided Marius for fighting againſt his country, cauſed him to be put to death. Alexander and Dionyſius were reſerved for the triumph; but the latter poiſoned himſelf to avoid that diſgrace. Lucullus then ſteered his courſe for Bithynia, on receiving intelligence that Mithridates had appeared with his fleet on thoſe coaſts: but the king having notice of his approach, made what haſte he could to gain Pontus, and arrived at Heraclea on board a pirate named *Selemus*; with whom he was obliged to truſt himſelf, his fleet being diſperſed by a violent ſtorm, and the ſhip that carried him caſt away.

43
Farther ſucceſſes of Lucullus.

In the mean time Mithridates was no leſs unfortunate by land than by ſea. Triarius, one of the officers of Lucullus, reduced the cities of Apamea, Pruſa, Pruſias, and Nicæa. From thence he marched with all expedition to Nicomedia, where the king himſelf was, and near which place Cotta lay encamped. But before the two armies could be joined, Mithridates eſcaped, firſt to Heraclea, which was betrayed to him, and from thence to Sinope. Nor was Lucullus himſelf all this time inactive. Having reduced all Paphlagonia and Bithynia, he marched through Cappadocia, and joined Cotta and Triarius at Nicomedia, with a deſign to invade Pontus; but hearing that Heraclea was in the hands of Mithridates, he diſpatched Cotta to reduce that city. Triarius was ordered with the fleet to the Helleſpont and Propontis, to intercept the king's fleet, which was daily expected from Spain with ſupplies from Sertorius. Lucullus himſelf, with the main ſtrength of the army, purſued his march into Pontus. His army was greatly haraſſed, eſpecially in the narrow paſſes between Cappadocia and Pontus, by flying parties of the enemy. But the greateſt inconvenience was the want of proviſions, as the king's troops had laid waſte all the country round; inſomuch that Lucullus having loſt almoſt all his beaſts of burden, was obliged to take along with the army 30,000 Galatians, each of them carrying a ſack of corn on his back. At laſt, however, he gained the plains of Pontus; where proviſions were ſo plentiful, that an ox was ſold for a drachma, and every thing elſe in proportion.

The Roman general having now carried the war into the enemy's country, divided his forces, and at the ſame time inveſted a very ſtrong town named *Amiſus*; another called *Eupatoria*, built by Mithridates, and made the

Pontus.

the place of his reſidence; and another, named *Themiſcyra*, ſituated on the banks of the Thermodoon. Eupatoria was ſoon taken, but Themiſcyra made a vigorous reſiſtance. The townſmen galled the Romans to ſuch a degree, that, not daring to approach the walls openly, they contented themſelves with undermining them: but in this too they met with no ſmall difficulty; for the enemy countermined, and often engaged them, under ground, letting into the mines bears and other wild beaſts, with ſwarms of bees, which obliged them to abandon their works. However, the town was at laſt obliged to ſurrender for want of proviſions. As for Amiſus, Lucullus himſelf ſat down before it: but finding it ſtrongly fortified and garriſoned with the flower of the king's troops, the Roman general thought proper to reduce it by famine; and on this occaſion his countrymen firſt complained of him as protracting the war for his own advantage.

In the mean time Mithridates having recruited his ſhattered army, advanced to Cabiræ, a city not far diſtant from Amiſus. Lucullus, leaving part of the army to continue the ſiege, marched at the head of the reſt to oppoſe Mithridates. But the king having drawn his cavalry into a general engagement, defeated them with conſiderable loſs, and drove them back to the mountains, through the paſſes of which Lucullus had lately marched to attack him. This check obliged the Roman general to retire to a riſing ground near the city of Cabiræ, where the enemy could not force him to an engagement. Here proviſions beginning to grow ſcarce, Lucullus ſent out ſtrong parties from his army into Cappadocia, the only place from whence he could have ſupplies. One of theſe parties entirely defeated Taxiles and Diophantes, two of the king's generals, who had been ſtationed there to prevent Lucullus from having any communication with the country. The king, upon the news of this defeat, reſolved to break up his camp and retire, not queſtioning but that Lucullus would attack him as ſoon as his forces returned. This reſolution he no ſooner imparted to his nobles, than they began privately to ſend away their moſt valuable goods; which being found out by the ſoldiers, they took it in ſuch bad part that no intelligence had been given them, that they plundered their baggage, and put thoſe who had the care of it to the ſword. After this they betook themſelves to flight, crowding out of the gates in the utmoſt confuſion. The king haſtened to ſtop their flight; but nobody ſhowing him the leaſt reſpect, he was carried away by the crowd, and in great danger of being trampled to death. Having with difficulty made his eſcape, he retired with a ſmall retinue, firſt to Cabiræ, and then to his ſon-in-law Tigranes king of Armenia. Lucullus diſpatched the beſt part of his cavalry to purſue the fugitives; while he himſelf, with the reſt, inveſted the camp of Mithridates, where thoſe remained who could not fly with the reſt. The camp was eaſily taken; but moſt of the ſoldiers made their eſcape, while the Romans, contrary to their general's orders, were buſied in plundering. Lucullus then purſued hard after the king; who, being overtaken by a company of Galatians, cauſed a mule loaded with part of his treaſures to be driven in among them, by which means he made his eſcape while they quarrelled about the booty. Mithridates, remembering in his flight, that he had left his ſiſters, wives, and concubines

44
The army of Mithridates mutinies, which obliges the king to fly into Armenia.

at Pharnacia, diſpatched an eunuch, named *Bacchus* or *Bacchides*, with orders to put them all to death, leſt they ſhould fall into the hands of the enemy; which was accordingly done.

After the flight of Mithridates, the Romans no longer met with any oppoſition; the king's governors flocking from all parts to put themſelves under the protection of the conqueror. Among theſe was the grandfather of Strabo the geographer, whom the king had diſobliged by putting to death his couſin-german Tibias, and his ſon Theophilus. He was a man of ſuch credit, that it was no ſooner heard that he had abandoned the king's party, than 15 other commanders delivered up to Lucullus the places with which they had been intruſted; and about the ſame time Triarius falling in with the king's fleet near the iſland of Tenedos, obtained a complete victory, having either taken or ſunk 60 of the enemy's veſſels.

All this time Cotta had been employed without ſucceſs in beſieging Heraclea, which he could never have reduced without the aſſiſtance of Triarius. That commander, having defeated the fleet, ſoon reduced the town to ſuch diſtreſs, that a third part of the garriſon died of hunger; upon which the governor, Conacorix, privately agreed with Triarius to deliver one of the gates to him. This was accordingly done; and the Romans, entering, made a terrible ſlaughter of the helpleſs inhabitants. But in the mean time Cotta, provoked at ſeeing himſelf deprived both of all ſhare of the booty, and the honour of reducing a place before which he had ſat ſo long, fell upon his countrymen as they were buſied in plundering; which would have occaſioned a great deal of bloodſhed, had not Triarius promiſed to divide the booty equally. Conacorix, in order to conceal his treachery, after marching out of Heraclea, ſeized on two forts belonging to the Romans; and Triarius being ſent to recover them, Cotta, in his abſence, plundered the city anew, rifled the temples which the other had ſpared, put all the citizens he could meet with to the ſword, and having carried off every thing valuable, at laſt ſet fire to the city in ſeveral places, by which means it was ſoon reduced to aſhes. Cotta then, having no farther occaſion for his troops, diſmiſſed the auxiliaries, reſigned his legions to Lucullus, and put to ſea himſelf in order to return to Rome. But he had ſcarce got out of the harbour, when part of his ſhips, being overloaded with the ſpoils of the city, ſunk; and the others were by a violent north wind daſhed againſt the ſhore, which occaſioned the loſs of a great part of the booty. However, on his return to Rome, he was highly applauded by the ſenate, and honoured with the title of *Ponticus*.

Lucullus, having now reduced Pontus, marched againſt the Chaldeans, Tibarenians, and inhabitants of Armenia Minor; who voluntarily ſubmitted to him, and put him in poſſeſſion of all their ſtrong holds. From Armenia, he returned before Amiſus, which ſtill held out; Callimachus, governor of the place, having haraſſed the Romans to ſuch a degree by engines of his own contriving, that they had given over their aſſaults, and contented themſelves with blocking it up by land, though the garriſon was at the ſame time plentifully ſupplied with proviſions by ſea. Lucullus, on his arrival, ſummoned the city to ſurrender, offer-

ing

ing the inhabitants very honourable terms; but, being refused, he made a general assault at the time when he knew that Callimachus used to draw off great part of his troops to give them some respite. The Romans applying their scaling ladders, got over the wall before Callimachus could come to the assistance of those whom he had left to guard it; however, by setting the city on fire, he found means in that confusion to make his escape. Lucullus commanded his men to use their utmost endeavours to save the city; but they being intent only upon plundering, regarded nothing but the furniture. At last the fire was extinguished by a violent shower; and Lucullus, having with much ado restrained his soldiers from committing any farther excesses, repaired the city in some measure before he left it, and suffered the inhabitants to enjoy their possessions in peace.

45 ...ranes ...ted by ...ullus,

Nothing was now wanting but the captivity of Mithridates himself to put a final period to the war; and therefore Lucullus demanded him from his son-in-law Tigranes. But though that prince could not be prevailed to see Mithridates on account of his misconduct, he could as little be induced to deliver him up to his enemies. After this refusal, however, he for the first time condescended to see his father-in-law, after he had resided a year and eight months in his dominions. In a private conference held by the two kings, it was agreed, that Tigranes should march against the Romans, and Mithridates with 10,000 horse return into Pontus, where he should make what levies he could, and rejoin Tigranes, before Lucullus, who was then employed in the siege of Sinope, could enter Armenia. But, in the mean time, Sinope having surrendered, Lucullus with all possible expedition marched against Tigranes, and, having drawn him into a general engagement, gave him an entire defeat, as is related under the article ARMENIA.

46 ...resolves ...y ano... ...cam... ...n.

Mithridates was marching to his assistance, when he met his son-in-law flying with a small retinue to shelter himself in some remote corner of the kingdom. He encouraged him to raise new forces; not doubting but that another campaign would repair all former losses, provided he would commit to his management every thing relating to the war. To this Tigranes agreeing, as he thought him more fit to deal with the Romans than himself, orders were issued out for raising a new army, and all the Armenians able to bear arms summoned to meet at the place of the general rendezvous. Out of these Mithridates chose 70,000 foot and 35,000 horse; and having trained them up during the winter, after the Roman discipline, in the beginning of the spring he left part of them with Tigranes, and marched himself with the rest into Pontus, where he recovered many important places, and overcame in a pitched battle M. Fabius, whom Lucullus had appointed governor of that province. Being flushed with this success, as soon as the wounds he received in the engagement suffered him to move, he pursued Fabius, and besieged him in the city of Cabira, whither he had retired; but in the mean time Triarius, who was marching out of Asia to join Lucullus, hearing what distress the Romans were in, hastened to their relief, and appearing unexpectedly on the neighbouring hill, struck such terror into the enemy, that they raised the siege, and made the best of their way into Cappadocia. Triarius pursued them, and got so near them as to be parted only by a river. Here he halted, with a design to pass the river after he had allowed his men some rest; for they were tired out with long marches. But Mithridates was before-hand with him, and crossing the river on a bridge, where he had placed a strong guard, attacked the Romans with great resolution before they had time to refresh themselves. The battle was bloody, and the event doubtful, till the bridge breaking down with the weight of the multitude that passed, the king's troops who had engaged, relying chiefly on their numbers, began to lose courage, seeing they could receive no further assistance; and the Romans charging them with fresh vigour, they betook themselves to a precipitate flight. After this engagement, as winter came on, both armies were glad to retire to their winter-quarters.

Pontus.

47 Mithridates defeated.

During the winter, Mithridates raised new forces; and having received considerable supplies from Tigranes, took the field early in the spring, in hopes of driving the Romans quite out of Pontus, before Lucullus, who had work enough on his hands in Armenia, could come to their assistance. With this view he marched straight against Triarius and Sornatius, to whom Lucullus had committed the care and defence of that province; and finding them encamped near the city of Gaziursa, proffered them battle; which they declining, he sent a strong detachment to besiege a castle where the Romans had left all their baggage, hoping they would rather venture an engagement to relieve the place, than lose all they had got with so much toil and labour during the war: neither was he disappointed in his hopes; for though Triarius was for keeping close in his camp till the arrival of Lucullus, whom he daily expected, having acquainted him with the danger, the soldiers hearing that the castle was besieged, declared in a tumultuous manner, that if he did not lead them they would march to the relief of the place without his leave. Triarius being thus forced by his own men to fight, drew out his forces against the king, whose army was three times his number; but while they were upon the point of engaging, both armies were by a violent storm forced to retire to their respective camps; but Triarius receiving that very day intelligence of the approach of Lucullus, and fearing he would snatch the victory out of his hands, resolved to make a bold push, and next morning by break of day attack the king in his camp. If he conquered, the glory he thought would be entirely his own; if he were overcome, the enemy could reap no great advantage from his victory, Lucullus being at hand with a powerful army. The king, in that surprise, putting himself at the head of a few troops of his guards, sustained the brunt of the Romans, till the rest of his army drawing up came to his relief, and attacked the enemy with such fury, that the Roman foot were forced to give way, and were driven into a morass, where they were surrounded, and great numbers of them cut in pieces.

48 Defeats Triarius.

Their horse were likewise put to flight, and pursued with great slaughter, till a Roman centurion in the king's service, pitying his countrymen, attempted to kill him. The king's life was saved by his breastplate; but as he received a deep wound in the thigh, he was obliged to give over the pursuit himself, and those that were about him caused the retreat to be

Pontus. founded, which, as it was unexpected, occasioned a great confusion in the whole army. The centurion was immediately cut in pieces; but the Roman horse in the mean time getting the start of the enemy, found means to make their escape. Above 7000 of the Romans were killed in that battle; and among them 150 centurions and 24 tribunes, the greatest number of officers that had been lost in any engagement to that day.

49 All the Romans in the service of Mithridates massacred.

Mithridates being cured of his wound, that he might not for the future be exposed to such dangers, caused all the Romans that served in his army to be formed into one body, as if they were to be sent out on a party, and then ordered them to retire to their tents, where they were all to a man cut in pieces.

The king, however elated with success, yet would not engage Lucullus; but with long marches hastened into Armenia Minor, and encamped upon a hill near the town of Talura, expecting Tigranes, who was advancing with a strong army to join him. Lucullus, in pursuit of Mithridates, marched over the field of battle, leaving those unburied who had fallen in the engagement, which alienated the minds of the soldiery from him, and they began to be very mutinous; being stirred up by Appius Claudius, whom Lucullus had turned out of his command for his vile behaviour, notwithstanding he was nearly related to him, Lucullus having married his sister. The discontent that prevailed in the army came to such a height, that Lucullus was obliged to lie still in his camp all that summer; the soldiers declaring in a mutinous manner, that they would not follow him any longer, nor serve under a general who refused to share the booty with them.

50 Lucullus recalled, which retrieves the affairs of Mithridates.

These complaints, and the general discontent that reigned in the army, obliged the senate to recal Lucullus, and appoint Manius Acilius Glabrio, consul of that year, in his room. Glabrio arriving in Bithynia, gave notice by public criers to all the cities, that the senate had discharged Lucullus and his army, and confiscated his goods for protracting the war and refusing to comply with their injunctions. Hereupon Lucullus was abandoned by the greater part of his army, and forced to retire into Galatia, not being in a condition to make head against the joint forces of the two kings; who, laying hold of that opportunity, recovered the best part of Pontus, Bithynia, Cappadocia, and Armenia Minor: for though Glabrio had hastened into Pontus, as if he had intended to engage the enemy and rob Lucullus of the victory, yet, upon the first news of the approach of the two kings, he thought fit to retire and leave the country open on all sides to the enemy.

51 Pompey sent against him.

When this was heard at Rome, a law was enacted there by C. Manilius, a tribune of the people, whereby the management of the war against Mithridates and Tigranes was committed to Pompey, and likewise the provinces of Cilicia, then under Quintus Marcius, and of Bithynia under Glabrio. By the same law he was continued in that unlimited power by sea, with which he was invested when he first set out against the pirates of Cilicia. In virtue of this law, Pompey, who had just then ended the war with the Cilician pirates, took upon him the command of the army, and directed all the allies of the Roman people to join him with all possible expedition; but before he took the field, he renewed the alliance which Sylla and Lucullus had concluded with Phrahates king of Parthia, and then sent friendly proposals to Mithridates; who at first seemed inclined to give ear to them, and accordingly dispatched an ambassador to the Roman army to treat of a peace. Pompey required of him to lay down his arms if he was in earnest, and deliver up to him all those who had revolted from the Romans during the war. This demand was no sooner reported abroad in the king's camp, but the deserters, who were very numerous in the king's army, betaking themselves to their arms, threatened to put Mithridates himself to death; and would have occasioned a great disturbance, had not the king appeased the growing tumult, by assuring them, that he had sent ambassadors, not to treat of a peace, but only to take, under pretence of suing for peace, a view of the enemy's strength. He moreover obliged himself, by a solemn oath in the presence of the whole army, never to enter into any treaty of friendship with the Romans, nor to deliver up to them such as had ever served under him.

52 Mithridates rejects his proposals of peace.

Pompey, finding his proposals rejected, advanced against the king with an army of 30,000 foot and 20,000 horse, as Plutarch writes, or 30,000, as we read in Appian, all chosen troops; for he discharged most of those who had served under Glabrio and Lucullus. As he entered Galatia, he was met by Lucullus, who endeavoured to persuade him to march back, the war being near finished, and even deputies sent by the republic to settle the province of Pontus; but not being able to prevail with him, after mutual complaints against each other, they parted; and Pompey removing his camp, commanded the troops that were with Lucullus to join him, except 1600 whom he left to attend Lucullus in his triumph. From thence Lucullus set out for Rome, where he was received by the senate with great marks of esteem, most men thinking him highly injured by the authors of the Manilian law. Pompey pursued his march into Pontus; but finding that he could not by any means draw the king to a battle, he marched back into Armenia Minor, with a design either to reduce that province, or oblige Mithridates to venture a battle in order to relieve it. Mithridates followed him at some distance; and entering Armenia, encamped on a hill over-against the Romans, and, by intercepting their convoys, reduced them to such distress, that they were obliged to remove to a more convenient place, the king cutting off many in their rear, and harassing them with frequent attacks, till he fell into an ambuscade laid by Pompey, whose personal courage and prudent conduct on that occasion confirmed the king in his resolution not to hazard a general engagement. The two armies encamped over-against each other; Pompey on one hill, and the king on another, near the city of Dastira, in the province of Acisilene, at a small distance from the Euphrates, which divides Acisilene from Armenia Minor.

53 Is besieged by Pompey.

Here Pompey, seeing he could neither draw the king to a battle, nor force his camp, which was pitched on a steep and craggy mountain, began to block him up with a ditch which he carried round the bottom of the hill where the king was encamped; and meeting with no opposition, finished his work, and quite cut off the enemy's communication with the country. Pompey was amazed to see the king thus tamely suffer himself to be shut up; and could not help saying, That he was either a great fool or a great coward: a fool, if he did not

ontus. not apprehend the danger he was in; a coward, if, being appriſed of it, he did not to the utmoſt of his power prevent it. By this ditch, which was 150 furlongs in circuit, and defended by many forts raiſed at ſmall diſtances from each other, the king was ſo cloſely beſieged, that he could neither ſend out parties to forage, nor receive the ſupplies that came to him from Pontus. He was thus beſieged for the ſpace of 45 or 50 days; and his army reduced to ſuch ſtraits, that, having conſumed all their proviſions, they were at laſt forced to live on their dead horſes. Hereupon Mithridates reſolved at all events to break through the Roman fortifications: and accordingly, having put to the ſword all thoſe that were ſick or diſabled, that they might not fall into the enemy's hands, he attacked in the dead of the night the Roman guards; and having overpowered them with his numbers, got ſafe into the open fields, and continued his march all night towards Armenia Major, where he was expected by Tigranes.

54 breaks rough the oman es.

Pompey next morning by break of day purſued the enemy with his whole army; and having with much ado overtaken them, found the king encamped on a hill, to which there was but one aſcent, and that guarded by a ſtrong body of foot. The Romans encamped over-againſt them; but Pompey, fearing the king ſhould make his eſcape in the night-time, privately decamped, and taking the ſame rout the enemy were to hold in order to gain Armenia, poſſeſſed himſelf of all the eminences and defiles through which the king was to paſs. Mithridates thinking that Pompey was returned to his former camp, purſued his march, and about the duſk of the evening entered a narrow valley, which was ſurrounded on all ſides by ſteep hills. On theſe hills the Romans lay concealed, expecting the ſignal to fall upon the enemy and attack them on all ſides at once, while they were tired with their march, and ſeemingly, as they had ſent out no ſcouts, in great ſecurity. Pompey was at firſt for putting off the attack till the next morning, thinking it not ſafe to engage in the night-time among ſuch ſteep and craggy mountains; but was at laſt prevailed upon, by the earneſt prayers and intreaties of all the chief officers of the army, to fall upon the enemy that very night. It was therefore agreed, that in the dead of the night all the trumpets ſhould at once ſound the charge, that this ſignal ſhould be followed by an univerſal ſhout of the whole army, and that the ſoldiers ſhould make what noiſe they could, by ſtriking their ſpears againſt the braſs veſſels that were uſed in the camp. The king's army at this ſudden and unexpected noiſe, which was echoed again by the mountains, imagined at firſt that the gods themſelves were come down from heaven to deſtroy them; and the Romans charging them on all ſides with ſhowers of ſtones and arrows from the tops of the hills, they betook themſelves to a precipitate flight; but finding all the paſſes beſet with ſtrong bodies of horſe and foot, were forced to fly back into the valley, where, for many hours together, they were expoſed to the enemy's ſhot, without being able, in that confuſion, either to attack them or defend themſelves. They attempted indeed to make ſome reſiſtance when the moon roſe; but the Romans running down upon them from the hills, did not give them time to draw up, and the place was ſo narrow that they had not room even to make uſe of their ſwords. The king loſt on that occaſion 10,000

55 over-reached by Pompey, and totally defeated.

men, according to Appian, but 40,000, according to Eutropius and others. On Pompey's ſide there fell between 20 and 30 private men, and two centurions. Pontus.

Mithridates, at the head of 800 horſe, broke through the Roman army, and being after this effort abandoned by all the reſt, becauſe they were cloſely purſued by the enemy, he travelled all night attended by three perſons only, *viz.* his wife, or, as Plutarch calls her, his *concubine*, by name *Hypſicratia*, his daughter Dripetine, and an officer. At day-break he fell in with a body of mercenary horſe, and 3000 foot, who were marching to join him. By theſe he was eſcorted to the caſtle of Sinoria, ſituated on the borders of the two Armenias. As great part of his treaſures were lodged here, he rewarded very liberally thoſe who accompanied him in his flight; and taking 6000 talents, withdrew into Armenia. As ſoon as he entered the borders, he diſpatched ambaſſadors to Tigranes, acquainting him with his arrival; but that prince, who was then on the point of concluding a ſeparate peace with the Romans, clapped his ambaſſadors in irons, pretending that his ſon Tigranes had, at the inſtigation of Mithridates, revolted firſt to the Parthians, and then to the Romans. Mithridates finding himſelf thus abandoned, even by his ſon-in-law, left Armenia; and directing his courſe towards Colchis, which was ſubject to him, and not as yet invaded by the Romans, paſſed the Euphrates the fourth day, and got ſafe into his own territories.

56 Diſtreſs of Mithridates.

Pompey ſent out ſeveral parties in purſuit of the king; but remained himſelf with the main body of the army in the field of battle, where he built a city, calling it from that remarkable victory *Nicopolis*. This city, with the adjoining territory, he beſtowed upon ſuch of his ſoldiers as were old or diſabled; and many flocking to it from the neighbouring countries, it became in a ſhort time a very conſiderable place. This battle was certainly attended with very fatal conſequences for Mithridates; who was forced, his army being entirely either cut off or diſperſed, to abandon his own dominions, and fly for ſhelter to the moſt remote parts of Scythia. Pompey having concluded a peace with Tigranes, as we have related in the hiſtory of Armenia, and ſettled the affairs of that kingdom, began his march in purſuit of Mithridates through thoſe countries that lie about mount Caucaſus. The barbarous nations through which he paſſed, chiefly the Albanians and Iberians, attempted to ſtop his march, but were ſoon put to flight. However, he was obliged, by the exceſſive cold and deep roads, to paſs the winter near the river Cyrus. Early in the ſpring he purſued his march; but meeting with great oppoſition from the Iberians, a warlike nation, and entirely devoted to Mithridates, he was employed moſt part of the ſummer in reducing them. In the mean time, Mithridates, who had wintered at Dioſcurias, on the iſthmus between the Euxine and Caſpian ſeas, and had been joined there by ſuch of his troops as had made their eſcape from the late unfortunate battle, continued his flight through the countries of the Achæans, Zygians, Heniochians, Cercetans, Moſchi, and Colchians. Of theſe nations ſome received him kindly, and even entered into alliance with him; through others he was forced to make himſelf a way with his ſword.

57 He flies into Scythia, and from thence into other countries.

Pompey took the ſame rout, directing his courſe by

Pontus. by the ſtars, eſpecially in the northern parts of Scythia, and carrying with him even proviſion of water, to ſupply the army in the vaſt deſerts through which he marched. He ſpent two years in warring with theſe nations, and was often in danger of loſing both his life and his army: but at laſt he overcame them all; and believing Mithridates, of whom he could have no account, to be dead, he marched back into Armenia Minor, where he allowed ſome reſt to his ſoldiers, who were quite worn out with the hardſhips they had endured in that expedition. Having refreſhed his army, he marched into Pontus, to reduce ſome ſtrongholds which were ſtill garriſoned by the king's troops. While he was at Aſpis in Pontus, many of the king's concubines were brought to him; but he ſent them all home to their parents, without offering them the leaſt injury, and thereby gained the affection of the chief lords of Pontus, whoſe daughters they were. The ſtrong caſtle of Symphori was delivered up to him by Stratonix, one of the king's concubines, upon no other terms than that he would ſpare her ſon Xiphares, who was with the king, in caſe he ſhould fall into his hands. She likewiſe diſcovered to him great treaſures hid under ground, which he, with great generoſity, beſtowed upon her, reſerving for himſelf only ſome veſſels to ſet off his triumph. Having taken another fort, called the *New Caſtle*, and to that time looked upon as impregnable, he found in it great ſtore of gold, ſilver, and other valuable things, which he afterwards conſecrated to Jupiter Capitolinus. Here, in looking over the king's manuſcripts, he came to diſcover where the reſt of his treaſures were concealed, what troops he could raiſe and maintain, what ſums were yearly paid him by his ſubjects and tributaries, &c. whereby he could make a true eſtimate of his whole power and wealth. Amongſt other manuſcripts he found ſome books of phyſic, wrote by Mithridates himſelf, which he commanded Lenæas, a learned grammarian, to tranſlate into Latin.

58 Pompey's further conqueſts.

Pompey, having thus reduced all Pontus, marched into Syria, with a deſign to recover that kingdom, and paſſing through Arabia to penetrate as far as the Red Sea. But while he was employed in this expedition, news was brought him that Mithridates, whom he believed dead, had appeared unexpectedly in Pontus at the head of a conſiderable army, and ſurpriſed Panticapæum, a famous empory at the mouth of the Euxine Sea. He had lain all this time concealed in the territories of a Scythian prince, adjoining to the Palus Mœotis; but hearing that Pompey had left Pontus, and was engaged in other wars, he ventured out of his hiding-place, reſolved either to recover his paternal kingdom, or die in the attempt. He returned privately into Pontus, and managed matters there ſo dexterouſly, that the Roman garriſons knew nothing of his arrival till he appeared with a conſiderable army in the field. He advanced firſt to the caſtle of Symphori; and underſtanding that Stratonix had delivered it up to Pompey, on condition he would ſave the life of her ſon in caſe he ſhould take him priſoner, the king immediately cauſed the youth, who was in his army, to be put to death, and his body to be left unburied, Stratonix beholding from the walls the cruel and unnatural murder, for he was her ſon by Mithridates, and had ſerved him with great fidelity.

59 Mithridates appears again at the head of a conſiderable army.

At the ſame time he ſent ambaſſadors to Pompey to treat of a peace, offering to pay a yearly tribute to the republic, on condition he reſtored to him his kingdom. Pompey replied, that he would hearken to no propoſals whatſoever, without the king came to treat with him in perſon, as Tigranes had done. This Mithridates looked upon as nowiſe conſiſtent with his dignity; and therefore laying aſide all thoughts of an accommodation, began to make what preparations he could for renewing the war.

He ſummoned all his ſubjects that were able to bear arms to meet at an appointed place; and having choſen out of the whole multitude 60 cohorts, each conſiſting of 100 men, he incorporated them with the regular troops that were already on foot. Being now in a condition to act offenſively, for Pompey had left but a ſmall number of troops in Pontus, he poſſeſſed himſelf of Phanagorium, Cherſoneſus, Theodoſia, Nymphæum, and ſeveral other important places. But in the mean time, Caſtor, whom Mithridates had appointed governor of Phanagorium, falling out with Tripho, one of the king's favourite eunuchs, killed him, and dreading the king's reſentment, ſtirred up the inhabitants to a revolt: by which means Phanagorium was again loſt; but the caſtle, which was defended by four of the king's ſons, Artaphernes, Darius, Xerxes, and Oxathres, held out for ſome time. The king haſtened to their relief; but the caſtle being ſet on fire by the rebels, they were forced to ſurrender themſelves to Caſtor before his arrival. Theſe four ſons, with one of the king's daughters, by name *Cleopatra*, Caſtor ſent to the Romans; and fortifying himſelf in the town, perſuaded moſt of the neighbouring cities, which were oppreſſed with heavy taxes, and ſtrangely haraſſed by the king's collectors, to join in the rebellion.

60 Recovers ſeveral places.

Mithridates finding that he could neither rely upon the ſoldiery, moſt of them being forced into the ſervice, nor on his other ſubjects, who were diſſatisfied by reaſon of the exorbitant taxes, ſent ambaſſadors to invite the princes of Scythia to his relief, and with them his daughters, to be beſtowed in marriage upon ſuch as ſhowed themſelves moſt inclined to aſſiſt him. But as the ambaſſadors he employed on this occaſion were eunuchs, a race of men no leſs abhorred by the army than favoured by the king, over whom they had a great aſcendant, eſpecially in his old age, the ſoldiers who were ſent to attend them on their journey, put them all to the ſword as ſoon as they were out of the king's reach, and delivered his daughters up to the Romans. Mithridates, finding himſelf thus deprived of his children, betrayed by his army, and forſaken even by thoſe on whom he chiefly relied, could not yet be induced to ſubmit to the Romans, though Pompey promiſed him honourable conditions, provided he came to treat with him in perſon. In this deſperate condition, he left no ſtone unturned to ſtir up the princes of Aſia againſt the Romans, eſpecially the Parthians; but finding them awed by the great opinion they all had of Pompey, he had recourſe at laſt to the European Gauls, whom he underſtood to be at war with the Romans; and having ſent before ſome of his truſty friends to engage them in his favour, taking leave of his own kingdom, he began his long march, deſigning to paſs through Boſphorus, Cimmerius, Scythia,

61 His ſubjects diſcontented.

62 His extraordinary deſign of invading Italy.

ontus. thia, Panonia, &c. and joining the Gauls, paſs the Alps, and invade Italy.

This deſign was no ſooner known in the army, but the ſoldiers openly began to complain and mutiny; exaggerating the boldneſs of the attempt, the length of the march, and the unſurmountable difficulties that muſt neceſſarily attend ſuch a deſperate enterpriſe. The chief commanders did all that lay in their power to divert him from it; repreſenting to him, that if he was not able to cope with the Romans in his own kingdom, much leſs would he be a match for them in Italy or Gaul, where they could daily receive new ſupplies; whereas he would loſe the greateſt part of his army in ſo long and difficult a march, and the reſt perhaps in the firſt engagement, without any poſſibility of repairing the loſs. But all was to no purpoſe; for they found him ſo unalterably fixed in his reſolution, that he cauſed thoſe to be put to death who with moſt warmth remonſtrated againſt it, not ſparing even his own ſon Exipodras, for dropping ſome unguarded expreſſions on that occaſion. Thus they were forced to let him purſue his own meaſures, till they found a more proper opportunity to oppoſe them, which ſoon after offered, as they were encamped at Boſphorus Cimmerius, on their march into Scythia.

63 ...s ſon ...arnaces ...olts.

Here Pharnaces, the king's favourite ſon, whom he had appointed to ſucceed him, obſerving the general diſcontent that reigned in the army, began to entertain thoughts of placing the crown on his own head; and not doubting but the ſoldiery would ſtand by him, if he declared againſt the intended expedition into Italy, openly proteſted among the Roman deſerters, who were a conſiderable part of the army, that if they would follow him he would return into Pontus. The Romans, who were well appriſed of the danger that attended ſuch an undertaking, and had moſt of all exclaimed againſt it, promiſed to ſupport him to the utmoſt of their power, and even encouraged him, upon ſome expreſſions which he purpoſely dropped, to aſſume the title of *king*, a title which his father ſeemed determined to hold till he had deſtroyed, by his raſh and deſperate attempts, himſelf, his friends, and his army. Pharnaces, finding he could depend on the Romans, engaged the ſame night moſt of the chief commanders in his party, and by their means the greater part of the ſoldiery. It was agreed, that next morning by break of day all thoſe who had declared in his favour ſhould appear in arms, and with a loud ſhout proclaim Pharnaces king; which was done accordingly, and the ſhout returned even by thoſe whom Pharnaces had not thought fit to let into the ſecret. The king, who had taken up his quarters in the city, being awaked by the noiſe, ſent out ſome of his domeſtics to know what had happened in the army. Neither did the officers or ſoldiers diſſemble the matter, but boldly anſwered, that they had choſen a young king inſtead of an old dotard governed by eunuchs.

Hereupon Mithridates mounting on horſeback, and attended by his guards, went out to appeaſe the tumult: but his guards forſaking him, and his horſe being killed under him, he was obliged to fly back into the city; from whence he ſent ſeveral of his attendants one after another to deſire of his ſon a ſafe conduct for himſelf and his friends. But as none of the meſſengers returned, ſome being ſlain, and others ſiding with the new king, Mithridates endeavoured to move his ſon to compaſſion, by ſignifying to him from the walls the diſtreſſed condition he was reduced to by a ſon whom he had favoured above the reſt of his children; but finding him nowiſe affected by his ſpeech, turning to the gods, he beſeeched them with many tears to make his ſon know one day by experience the grief and agony which a father muſt feel in ſeeing his love and tenderneſs requited with ſuch ungrateful and monſtrous returns. Having thus ſpoke, he thanked in a very obliging manner thoſe who had ſtood by him to the laſt, and exhorted them to make their ſubmiſſion to the new king on the beſt terms they could procure; adding, that as for himſelf, he was determined not to outlive the rebellion of a ſon whom he had always diſtinguiſhed with particular marks of paternal affection.

64 Mithridates attempts to deſtroy himſelf.

After this, he withdrew into the apartment of his wives and concubines, where he firſt took poiſon himſelf, and then preſented it to them, and to his favourite daughters Mithridatis and Niſſa, who not long before had been betrothed to the kings of Egypt and Cyprus. To the women it proved immediate death; but on the king, who from his infancy had inured his conſtitution to poiſonous potions, it had ſo ſlow an operation, that he was forced, through fear of falling into the rebels hands, to recur to his ſword. Neither did the wound, as he was greatly weakened by the poiſon, prove mortal: ſo that the rebels, having in the mean time ſtormed the town, and broke into the houſe, found the king wallowing in his blood, but ſtill alive, and in his ſenſes; which Pharnaces hearing, ſent ſome of thoſe that were about him to dreſs his wounds, with a deſign to deliver him up to the Romans, and thereby ingratiate himſelf with Pompey.—

65 A Gaul puts an end to his life out of compaſſion.

But, in the mean time, a Gaul, who ſerved in the army, by name *Bitætus*, or *Bithocus*, entering the king's room in queſt of booty, and being touched with compaſſion in ſeeing him forſaken by all his friends, and ſtruggling on the bare ground with the pangs of death, drawing his ſword, put an end to his preſent agonies, and prevented the inſults which he chiefly apprehended if he ſhould fall alive into his ſon's hands. The barbarian is ſaid, when he firſt ſaw the king, to have been ſo awed with the majeſty of his countenance, that, forgetful of his booty, he fled out of the room; but being called back, and earneſtly intreated by the dying prince to put an end to his miſery, he ſummoned all his courage to perform, as he did, with a trembling hand, that office; and immediately retired without touching any thing that belonged to the king, though the hopes of a rich booty was the only motive that had led him thither.

Pompey, who was at that time engaged in a war with the Jews, received the firſt notice of the death of Mithridates as he was on his march to Jeruſalem. The meſſenger who brought the joyful tidings was ſent by Pharnaces, and appeared unexpectedly before Pompey with the branch of a laurel, as was cuſtomary on the like occaſions, twiſted round the head of his javelin.

66 Exceſſive joy of the Romans at his death.

When he heard what had happened at Panticapæum, he was ſo impatient to impart it to the ſoldiery, that he could not even wait till they had raiſed him a mount of turf from whence to ſpeak to the army, according to the cuſtom of the camp; but ordered thoſe

Pontus. those who were by him to form a kind of mount with their saddles, and from thence acquainted the soldiery that Mithridates had laid violent hands on himself, and his son Pharnaces was ready to acknowledge the kingdom as a gift of the people of Rome, or resign it if they were unwilling he should reign. This news was received with joyful shouts of the whole army, and the day solemnized with feasts and sacrifices throughout the camp, as if in Mithridates alone all the enemies of the republic had died. Pompey dispatched without delay a messenger with letters to the senate, acquainting them with the death of Mithridates, and the submission of his son Pharnaces. When his letters were read, the senators were so overjoyed, that they appointed, at the proposal of Cicero, then consul, 12 days for returning due thanks to the gods, who had delivered them from such an insulting and powerful enemy; and the tribunes of the people enacted a law, whereby Pompey, in consideration of his eminent service in the Mithridatic war, was to wear a crown of laurel, with the triumphal gown at the Circensian sports, and a purple gown at the scenical plays.

Pharnaces, when he heard of his father's death, caused his body to be preserved in brine, proposing to present it to Pompey, who had promised to return into Pontus after the reduction of Judæa, and there settle matters to his satisfaction. And accordingly having taken the city and temple of Jerusalem, he set out with two legions for Pontus; and being arrived at Sinope, he was there met by ambassadors from Pharnaces, acquainting him, that their master had forbore assuming the title of king till his will and pleasure were known; that he put both himself and the kingdom entirely into his hands; and that he was willing to attend him at what time or place he thought fit to appoint. The same ambassadors delivered up to Pompey those who had taken Manius Aquilius the Roman legate, whom Mithridates had put to a cruel death, all the prisoners, hostages, and deserters, whether Romans, Greeks, or Barbarians, and the body of Mithridates, with his rich apparel and arms, which were greatly admired by Pompey and the other Romans. Both soldiers and officers flocked to see the king's body; but Pompey declined that sight; and, saying that all enmity between that great prince and the people of Rome was ended with his life, he returned the body to the ambassadors, and caused it to be interred with the utmost pomp and magnificence among his ancestors in the burying-place of the kings of Pontus, Pompey defraying all the charges of that ceremony, which was the most costly and pompous that ever had been seen in those parts. With the body Pompey restored his wearing apparel and armour; but the scabbard of his sword, which cost 400 talents, was stolen by Rublius a Roman, and sold to Ariarathes king of Cappadocia; and his cap or turban, which was a very curious piece of workmanship, was privately taken by one Caius, who presented it to Faustus the son of Sylla, in whose house it was kept, and shown for many years after among the many rarities which Sylla had brought out of Asia.

67 Submissive embassy of Pharnaces to Pompey;

Pompey bestowed the kingdom of Bosphorus on Pharnaces, and honoured him with the title of a friend and ally of the people of Rome. Pharnaces being thus acknowledged king of Bosphorus, sent orders to all the garrisons of Pontus to submit themselves, with the castles and treasures with which they were entrusted, to Pompey, who by that means amassed an immense booty. In the city of Talaura, which Mithridates used to call his wardrobe, he found 2000 cups of onyx set in gold, with such store of gold and silver vessels, of costly furniture, of saddles, bridles, and trappings, set with jewels and precious stones, that the Roman commissaries spent 30 days in taking the inventory of the whole. In another castle he found three large tables with nine salvers of massy gold, enriched with precious stones to an inestimable value; the statues of Minerva, Mars, and Apollo, of pure gold and most curious workmanship; and a pair of gaming-tables of two precious stones, three feet broad, and four feet long, on which was a moon of gold weighing 30 pounds, with their men, all of the same precious stone. In a fort situated among the mountains, were delivered up to him the king's statue of massy gold, eight cubits high, his throne and sceptre, and the bed of Darius the son of Hystaspes. Most of these treasures had been transmitted to him from his ancestors, chiefly from Darius king of Persia; some belonged to the Ptolemies of Egypt, and had been deposited by Cleopatra, as we have hinted above, in the hands of the Coans, who delivered them to Mithridates; and great part of them had been collected by the king himself, who was very fond of rich and stately furniture.

Pompey having thus got entire possession of Pontus, and reduced it to the form of a Roman province, marched into *Asia* properly so called; and having wintered at Ephesus, early in the spring set out for Italy, with a fleet of 700 ships. As he brought over his army with him, the senate was under no small apprehension lest he should make himself absolute, and rule without controul. But he no sooner landed at Brundusium, than he disbanded the army, without waiting for any decree either of the senate or people; what neither his friends nor his enemies had believed. His triumph lasted two whole days; and though he was attended in his triumphal chariot by 324 captives of distinction, among whom were five sons and two daughters of Mithridates, yet he would not suffer any of them to be put to death, as had been done by others; but sent them all back, except such as were of royal extraction, to their respective countries, and even supplied them with money to defray the charges of their journey. After his triumph he delivered into the treasury 20,000 talents, though, at the dismissing of the army, he had divided 16,000 talents among the tribunes and centurions, 2000 sestertiums among the quæstors, and had given to each soldier 50 sestertiums.

68 Who bestows upon him the kingdom of Bosphorus

Pompey had no sooner left Asia, but Pharnaces fell unexpectedly upon the Phanagorenses, a people of Bosphorus, whom Pompey had declared free, because they had revolted the first of all from Mithridates, and by their example induced others to abandon the king's party. Pharnaces besieged their chief city Phanagoria, and kept them blocked up till, for want of provisions, they were forced to sally out, and put all to the issue of a battle; which proving unsuccessful, they delivered up themselves and their city to the conqueror. Some years after, the civil war breaking out between Cæsar and Pompey, he laid hold of that opportunity

69 Pharnaces falls out with the Romans.

ntus

to recover the provinces which his father had formerly possessed; and having raised a considerable army, overran Pontus, Colchis, Bithynia, Armenia, and the kingdom of Moschis, where he plundered, as Strabo observes, the temple of the goddess Leucothea. He took the strong and important city of Sinope, but could not reduce Amisus. But, in the mean time, Cæsar having got the better of Pompey and his party, appointed Cn. Domitius Calvinus governor of Asia, enjoining him to make war upon Pharnaces with the legions that were quartered in that province. Domitius immediately dispatched ambassadors to Pharnaces, commanding him to withdraw his troops from Armenia and Cappadocia. The king returned answer, that he was willing to abandon Cappadocia, but as for the kingdom of Armenia Minor, it was part of his hereditary dominions; and therefore he would not resign it till he had an opportunity of laying his pretensions before Cæsar himself, whom he was ready to obey in all things. Hereupon Domitius drawing together what forces he could, marched into Cappadocia, which he recovered without opposition, Pharnaces having abandoned it to make a stand in Armenia, which lay nearer his own dominions. Thither Domitius pursued him; and having overtaken him near Nicopolis, found his army drawn up in battle-array, and the king ready to come to an engagement; which Domitius not declining, both armies advanced.

70
d de-
ts them.

The king, at the head of a choice body of men, fell upon the Romans left wing, consisting mostly of raw and undisciplined Asiatics; and having without much ado put them to flight, penetrated to the centre, where the thirty-fifth legion, the only one which Domitius had, after a faint resistance, gave ground, and, retiring to the neighbouring mountains, left their allies to shift for themselves, who were all cut off. Domitius with the remains of his scattered army marched back into Cappadocia; and from thence, winter drawing on, into the province of Asia. The king being puffed up with this victory, and hearing that Cæsar, with the flower of the Roman forces, was engaged at the siege of Alexandria, appointed one Asander governor of Bosphorus, and marched himself into Cappadocia in pursuit of Domitius, with a design to invade Asia, and recover all the provinces which had been once subdued by his father. Bithynia and Cappadocia readily submitted; but Armenia the Lesser, which was held by Dejotarus, made so vigorous a resistance, that he was forced to give over the enterprise, lest the Romans should in the meantime strengthen themselves in Asia, whither he was in haste to march, in hopes of meeting there with the same success as his father Mithridates had done. But before he reached that province, he was informed that Asander had revolted, in hopes of gaining thereby the good-will of the Romans, and obtaining of them the kingdom of Bosphorus for himself. At the same time, he received intelligence that Cæsar, having at last reduced Alexandria, and settled the affairs of Egypt and Syria, was marching into Armenia.

71
ttempts
outwit
lius Cæ-
r,

He was not a little dismayed at this news, and therefore without delay dispatched ambassadors to sue for peace; hoping that Cæsar, who was hastening into Italy with a design to pass over into Africa, would willingly give ear to any proposals of that nature.—Cæsar courteously entertained the ambassadors; and though he did not propose to agree to their conditions, yet, that he might come upon Pharnaces unawares, he showed himself very desirous of entering into a treaty of peace. But, in the mean time, he pursued his march with all possible expedition; and arriving on the confines of Pontus, ordered all the troops that were quartered in the neighbouring provinces to join him; for he had brought from Alexandria but one legion, namely, the sixth, and that consisting of 1000 men only, the rest having been killed at the siege of Alexandria. Besides this veteran legion, he found at the place of general rendezvous three others, but all of them very indifferently armed, and worse disciplined. With these forces, however, such as they were, he advanced against Pharnaces; who being greatly frightened at his approach, by reason of the success that had attended him in all his expeditions, again dispatched ambassadors to him with a crown of gold, offering him his daughter in marriage, and promising to do whatever he should require. The ambassadors took care to let him know that their master, though highly obliged to Pompey, yet had never been prevailed upon to send him any supplies during the civil war, which Dejotarus, king of Armenia the Lesser, whom he had honoured with his friendship, had done. Cæsar returned for answer, that he was willing to conclude a peace with Pharnaces, provided he retired without delay from Pontus, returned all the captives and hostages whether Roman or their allies, and restored the goods of the Roman citizens and publicans which he had seized since he first took up arms. He added, that as to his not sending supplies to Pompey, they ought rather to have concealed such an ungrateful proceeding of their master, than alleged it as any merit, since the forsaking of one to whom he was indebted for his crown, bespoke him a man of mean, selfish, and unworthy principles.

Pontus.

Pharnaces, upon the return of his ambassadors, acquainted Cæsar that he agreed to the conditions; but finding that Cæsar's affairs called him into Italy, he required a longer term of time for the performance of what was stipulated between them, starting daily new difficulties, in hopes that Cæsar would in the mean time be obliged to depart, and leave the affairs of Pontus in the same posture he had found them. Cæsar seeing himself disappointed, and put off from day to day, could not longer brook the king's deceitful behaviour. Wherefore he determined to put himself at the head of his small army, and attack the enemy in his camp when he least expected it. And accordingly, marching out in the night, he came by break of day in sight of the king's army; and uttering these words, *Shall this treacherous parricide go unpunished?* broke into the camp at the head of 1000 horse. The king's chariots, which were armed with scythes, caused some small disorder among Cæsar's horse; but in the mean time the rest of his army coming up, he put the enemy to flight, and obtained a complete victory. This battle was fought near the place where Mithridates had routed with great slaughter the Roman army under the command of Triarius. Most of the king's army were either taken or cut in pieces; but Pharnaces himself had the good luck to make his escape while the Romans were busy in plundering the camp. This victory was so quick, that

72
By whom
he is entirely defeated.

Cæsar

Pontus. Cæſar in a letter to his friend Aminitius, or Anitius, at Rome, expreſſed it in three words, thus: "I came, I ſaw, I conquered." He ever afterwards uſed to call Pompey a fortunate rather than a great commander, ſince he had gained his chief glory in the Mithridatic war, fighting with ſo cowardly an enemy. He divided the rich booty and the ſpoils of the camp among his ſoldiers; and becauſe Mithridates had erected a trophy near that place as a monument of his victory over Triarius, which Cæſar, as it was conſecrated to the gods, did not think lawful to pull down, he ſet up another over-againſt it to tranſmit to poſterity his victory over Pharnaces. After this victory he recovered and reſtored to the allies of the people of Rome all the places which Pharnaces had poſſeſſed himſelf of during the war, declared Amiſus a free city, and appointed Mithridates Pergamenus king of Boſphorus in the room of Pharnaces.

Having thus ſettled the affairs of Pontus, he ſet ſail for Italy; leaving Domitius Calvinus to purſue the war againſt Pharnaces, if he ſhould appear again in the field. Pharnaces had retired after the battle to Sinope with 1000 horſe, where he was quickly beſieged by Domitius, to whom he ſurrendered the town, upon no other condition than that he ſhould be ſuffered to retire into Boſphorus with the ſmall body that attended him. This Domitius willingly granted; but cauſed all the king's horſes to be killed, ſince he had aſked a ſafe-conduct only for his horſemen. With theſe and a band of Scythians and Sarmatians he attempted to recover the kingdom of Boſphorus; but being met between Theodocia and Panticapeum, both which cities he had reduced, by Aſander, who was ſtill in poſſeſſion of the kingdom, a ſharp engagement enſued, wherein the king's men, as not being uſed to fight on foot, were put to flight, and Pharnaces himſelf, who remained alone in the field, was ſurrounded by the enemy, and cut in pieces, after having reigned in Boſphorus Cimmerius, the kingdom which Pompey had beſtowed upon him, according to Appian, fifteen years, according to others, ſeventeen.

73 Is killed in another engagement.

74 Pontus again made a kingdom by Marc Antony.

Upon the death of Pharnaces the kingdom of Pontus was again reduced to the form of a province, and ſo continued to the triumvirate of Marc Antony, who after the battle at Philippi conferred it upon Darius the ſon of Pharnaces for his ſervices during the civil war. He continued faithful to the Romans; but did nothing during his reign worth mentioning.

Darius was ſucceeded in the kingdom by Polemon, likewiſe preferred to that honour by Marc Antony. He was the ſon of Zeno, a famous orator of Laodicea, and greatly favoured by Antony. From him that part of Pontus which borders on Cappadocia borrowed the name of *Polemoniacus*. He attended Marc Antony in his expedition againſt the Parthians; and being taken priſoner in that unſucceſsful battle fought by Statianus, he was ſent by the king of the Medes, an ally of the Parthians, to conclude a peace with the Romans. In which embaſſy he acquitted himſelf ſo well, that Antony added the kingdom of Armenia to his own dominions. In the war between Antony and Auguſtus he ſided with the former: but after the battle of Actium he was received into favour by the latter; and being ſent by Agrippa againſt Scribonius, who upon the death of Aſander had uſurped the kingdom of Boſphorus, he overcame him, and reduced the kingdom of Colchis, which was beſtowed upon him by Agrippa, who likewiſe honoured him with the title of *friend and ally of the people of Rome*. He afterwards waged war with the neighbouring barbarians refuſing to live in ſubjection to the Romans; but was overcome, taken, and put to death, by the Aſpungitani, a people bordering, according to Strabo, on the Palus Mœotis.

Upon his death his ſon Polemon II. was by the emperor Caligula raiſed to the throne of Boſphorus and Pontus. But the emperor obliged him to exchange the kingdom of Boſphorus with part of Cilicia; and Nero, with his conſent, reduced that part of Pontus which he enjoyed to the form of a province. He fell in love with Berenice, daughter to Agrippa king of Judæa; and in order to marry her embraced the Jewiſh religion. But as ſhe ſoon became tired of his riotous way of living, and returned to her father; ſo he renounced his new religion, and again embraced the ſuperſtitions of Paganiſm. Polemon dying without iſſue, the ancient kingdom of Pontus was parcelled out into ſeveral parts, and added to the provinces of Bithynia, Galatia, and Cappadocia, only that part of it which was called *Pontus Polemoniacus* retaining the dignity of a diſtinct and ſeparate province. During the civil diſcords between Veſpaſian and Vitellius, one Anicetus, firſt a ſlave, afterwards freedman, to king Polemon, and laſtly commander of the royal navy, took up arms with a deſign to reſcue the kingdom from the Roman bondage; and being joined by great multitudes drawn together with the proſpect of ſpoil, over-ran the country, and poſſeſſed himſelf of Trapeſund, a city founded by the Grecians on the utmoſt confines of Pontus. Here he cut in pieces a cohort made up of the inhabitants, but which had been formerly preſented with the privilege of Roman citizens. He likewiſe burnt the fleet, and with ſcorn and inſults ſcoured the ſea; Mucianus having called to Byzantium moſt of the Roman galleys. Hereupon Veſpaſian, who was at that time in Syria, ſent Verdius Gemnius into Pontus with a choice body of auxiliaries from the legions. He aſſailing the enemy while they were in diſorder, and roaming aſunder in purſuit of prey, drove them into their veſſels; then with ſome galleys chaſed Anicetus into the mouth of the river Chobus, where he thought himſelf ſafe under the protection of Sedochus king of the Lazians, whoſe alliance he had purchaſed with large ſums and rich preſents. Sedochus at firſt refuſed to deliver him up to the Romans; but was ſoon prevailed upon, partly by threats, partly by preſents, to ſurrender both him and all the other fugitives who had taken ſanctuary in his dominions. Thus ended that ſervile war; and the kingdom of Pontus continued to be a province of the empire till the time of David and Alexis Comneni, who being driven from Conſtantinople by the French and Venetians A. D. 1204, under the command of Baldwin earl of Flanders, ſettled, the one at Heraclea, the other at Trebiſond. The troubles that aroſe among the Latins gave Alexis Comnenus an opportunity of erecting here a new empire, which comprehended great part of Pontus, and was known by the name of the *empire of Trebiſond*. The Comneni held it about 250 years, till the time of Mohammed II. who carried David Comnenus, the laſt emperor of Trebiſond, priſoner to Conſtantinople, A. D. 1462, with all his family, and ſubjected his empire to that of Conſtantinople;

75 Is parcelled out into ſeveral provinces.

nople; in which abject slavery Trebisond and all Pontus have continued ever since.

PONTYPOOL, a town of Monmouthshire in England, seated between two hills. It is but a small place, though noted for its iron-mills, great manufacture of japanned mugs, &c. W. Long. 3. 6. N. Lat. 51. 42.

PONZA, or PONTIA, is a small island of the Tuscan Sea, well known to be the place to which many illustrious Romans were formerly banished. It is situated on the coast of Italy near Terracina, and in the neighbourhood of other small islands or rocks named *Palmarole*, *Zannone*, &c. between the island of Ventotienne and Monte Circello. All these islands were visited by Sir William Hamilton in the year 1785; and an account of his journey is given in a letter to Sir J. Banks, which appeared in the Phil. Transf. vol. lxxvi. p. 365. Sir William arrived at Ponza on the 20th August; and, according to his account, it lies about 30 miles from Ventotienne. On the 21st he went round it in a boat. Its length is about five miles, but its breadth is nowhere above half a mile, and in some places not more than 500 feet. It is surrounded by a multitude of detached rocks, some of them very high, and most of them composed of a compact lava. There are many irregularly formed basaltes, but none in large columns. In some places they have a reddish tinge from iron ochre, are very small, and irregularly laid over one another. Some stand perpendicularly, others obliquely, and some lie horizontally. The rocks themselves in which these masses are found are lava of the same nature with the basaltes. At first sight they appear like the ruins of ancient Roman brick or tyle buildings. One rock is composed of large spherical basalts, and in other places our author found the lava inclined to take the like spherical form, though on a much smaller scale, some of the former basalts being near two feet in diameter. All these rocks, in our author's opinion, have been detached by the sea from this island, which is entirely composed of volcanic matter, lavas, and tufas of various qualities and colours, as green, yellow, black, and white. Some of these matters are more compact in their texture than others; and in some parts great tracts seem to have undergone similar operations, which still subsist at a spot called the *Pisciarelli*, on the outside of the Solfatara, near Puzzole, and where a hot sulphureous vitriolic acid vapour converts all which it penetrates, whether lavas, tufas, volcanic ashes, or pumice-stones, into a pure clay, mostly white, or with a tint of red, blue, green, or yellow.

In one part of this island there is a sort of tufa remarkably good for the purpose of building. It is as hard as Bath-stone, and nearly of the same colour, without any mixture of lava or pumice-stone, which usually abound in the tufas of Naples, Baia, and Puzzoli.

The island of Palmarole which is about four miles from Ponza, is not much more than a mile in circumference. It is composed of the same volcanic matter, and probably was once a part of Ponza; and in our author's opinion it looks as if the island of Zannone, which lies about the same distance from Ponza, was once likewise a part of the same; for many rocks of lava rise above water in a line betwixt the two last-mentioned islands, and the water there is much more shallow than in the gulf of Terracina.

Zannone is much larger and higher than Palmarole; and that half of it next the continent is composed of a lime stone similar to that of the Apennines near it; the other half is composed of lavas and tufas, resembling in every other respect the soil of the islands just described. Neither Palmarole nor Zannone are inhabited; but the latter furnishes abundance of brushwood for the use of the inhabitants of Ponza, whose number, including the garrison, amounts to near 1700. The uninhabited island of St Stefano in like manner furnishes wood for the people of Ventotienne. It is probable that all these islands and rocks may in time be levelled by the action of the sea. Ponza, in its present state, is the mere skeleton of a volcanic island; little more than its hard or vitrified parts remaining, and they seem to be slowly and gradually mouldering away. The governor of the castle of Ponza, who had resided there 53 years, told our author that the island was still subject to earthquakes; that there had been one violent shock there about four years before; but that the most violent one he ever felt was on the very day and at the hour that Lisbon was destroyed. Two houses out of three which were then on the island were thrown down. "This (says our author) seems to prove that the volcanic matter which gave birth to these islands is not exhausted."

Fig. 1. Plate CCCCXII. is a plan of the island of Ponza as it is given in the Philosophical Transactions. Fig. 2. is a view of the inside of the harbour of the island. A in the same figure is a rock of lava. In many parts it is formed into regular basaltes of a reddish colour, tinged in all probability with some ochre. Most of the detached rocks of the island resemble this. BB represents a tract of volcanic country, converted by a hot sulphureous vitriolic acid vapour into a pure clay, the ground colour of which is mostly white.—Fig. 3. is a view from the outside of the harbour, near the lighthouse. C is a rock of volcanic matter converted to pure clay; D is a rock of the same kind, with strata of pumice-stone: E is a rock of lava, inclining to take basaltic forms; and F is a rock composed of spherical basaltes.

POOD is a Russian weight, equal to 40 Russian or 36 English pounds.

POOL is properly a reservoir of water supplied with springs, and discharging the overplus by sluices, defenders, weirs, and other causeways.

POOL, a sea-port town of Dorsetshire in England. It is surrounded on all sides by the sea, except on the north, where there is an entrance through a gate. It was formerly nothing but a place where a few fishermen lived: but in the reign of Henry VI. it was greatly enlarged, and the inhabitants had the privilege to wall it round. It was also made a county of itself, and sent two members to parliament. It is governed by a mayor, a senior bailiff, four other justices, and an indeterminate number of burgesses. The town consists of a church and about 600 houses, with broad paved streets; and has a manufactory of knit hose. It is 47 miles west-south-west of Winchester, and 110 west-by-south of London. W. Long. 2. 0. N. Lat. 50. 42.

POOLE (Matthew), a very learned writer in the 17th century, was born at York in 1624. He was educated at Emanuel-college, Cambridge, and afterwards incorporated in the university of Oxford. He succeeded Dr Anthony Tuckney in the rectory of St Michael de Quern, in London, about 1648. In 1658 he

he fet on foot a project for maintaining youths of great parts at the univerfities, and had the approbation of the heads of houfes in both of them. He folicited the affair with fo much vigour, that in a fhort time 900 l. *per annum* was procured for that purpofe; but this defign was laid afide at the Reftoration. In 1662 he was ejected from his living for nonconformity. He was ten years employed in compofing his *Synopfis Criticorum*, &c. Befides this great work he publifhed feveral other pieces. When Dr Oates's depofitions concerning the popifh plot were printed, our author found his name in the lift of thofe who were to be cut off, on the account (as was fuppofed) of what he had written againft the papifts in his *Nullity of the Romifh Faith*. So that he was obliged to retire into Holland, where he died in 1679, and left behind him the character of a very able critic and cafuift.

POOP, the ftern of a fhip; or the higheft, uppermoft, and hinder part of a fhip's hull. See STERN.

POOR, in law, an appellation given to all thofe who are in fuch a low and mean condition, that they either are or may become a burden to the parifh.

They who rank pity amongft the original impulfes of our nature rightly contend, that when it prompts us to the relief of human mifery, it indicates fufficiently the Divine intention, and our duty. Indeed, the fame conclufion is deducible from the exiftence of the paffion, whatever account be given of its origin. Whether it be inftinct, or a habit founded in affociation (fee PASSION), it is in fact a property of our nature which God appointed: and the final caufe for which it was appointed is to afford to the miferable, in the compaffion of their fellow-creatures, a remedy for thofe inequalities and diftreffes to which many are neceffarily expofed under every poffible rule for the diftribution of property. That the poor have a claim upon the rich, founded in the law of nature, can be queftioned by no man who admits the benevolence of the Deity, and confiders his purpofe in creating the world (fee THEOLOGY, Part I. Sect. ii.); and upon this claim the Chriftian Scriptures are more explicit than almoft upon any other.

The rights of the poor, however, to be relieved by the rich, as they originate in nature, and are fanctioned by Chriftianity, are evidently of that kind which is called *imperfect* (See MORAL *Philofophy*, n° 151.) It is furely needlefs to warn our readers in this place, that imperfect rights are in themfelves as facred, and the duties refulting from them as obligatory in *foro confcientiæ*, as the moft rigid claims of juftice. Every one knows, that they are called *imperfect* only becaufe the extent of them in particular inftances cannot be afcertained by pofitive laws, nor the breach of them be punifhed by the civil magiftrate. Hence the apoftle, tho' he enjoins a weekly contribution to be made for the poor in the church of Corinth, yet leaves the fum to be contributed by each individual wholly undetermined. "Now concerning the collection for the faints, as I have given order to the churches of Galatia, even fo do ye. Upon the firft day of the week let every one of you lay by him in ftore as God hath *profpered him*." By which St Paul certainly recommends to every man to contribute, not a fixed fum, but as much as, from a deliberate comparifon of his fortune, with the reafonable expences and expectations of his family, he finds he can fpare for charitable purpofes.

It is well known that thofe weekly contributions were laid at the feet of the apoftles, who transferred the management of the fund thence arifing to deacons elected by the people, and ordained by them to fee that the money was properly diftributed. Hence, under Chriftianity, the maintenance of the poor became chiefly an ecclefiaftical concern; and when that holy and benevolent religion was eftablifhed in the Roman empire, a fourth part of the tithes was in fome countries of Europe, and particularly in England, fet apart for that purpofe. Afterwards, when the tithes of many parifhes were appropriated to the monafteries, thefe focieties were the principal refource of the poor, who were farther relieved by voluntary contributions. Judge Blackftone obferves, that till the ftatute 26 Hen. VIII. cap. 26. he finds no compulfory method for providing for the poor; but upon the total diffolution of the monafteries, abundance of ftatutes were made in the reign of King Henry VIII. Edward VI. and Elizabeth, which at laft eftablifhed the

Poor's Rate, or legal affeffment for the fupport of the poor. The fums that had been appropriated for charitable ufes before the reformation were immenfe, and the wealth that had been accumulated through a fucceffion of ages by mendicant orders of religious perfons was inconceivably great; nor was it in the power of any laws to confine men who were in the poffeffion of fuch wealth from gratifying thofe defires which money can fo eafily find means of fupplying. Yet among the various abufes to which this opulence had given rife, thefe religious orders had never fo far loft fight of their original inftitution as ever to neglect the poor. Thefe were indeed provided for by them with an indifcriminate profufion of largeffe, better proportioned to their own opulence than to the wants of the claimants, who were too often, without examination, all equally ferved, whether deferving or undeferving of that bounty which they claimed.

When the *religious houfes*, as they were called, were entirely fuppreffed at the reformation, and the wealth that belonged to them was diverted into other channels, the poor, who had been in ufe to receive their fupport from thence, were of courfe left entirely deftitute; and this foon became a grievance fo intolerable not only to the poor themfelves, but to the whole nation, as to excite a univerfal defire to have it remedied. Accordingly, by the 14 Eliz. cap. 5. power was given to the juftices to lay a general affeffment; and this hath continued ever fince. For by 43 Eliz. cap. 2. the churchwardens and overfeers of the poor of every parifh, or the greater part of them (with the confent of two juftices, one of whom is of the quorum, dwelling in or near the parifh), are empowered to raife weekly, or otherwife, by taxation of every inhabitant, parfon, vicar, and other, and of every occupier of lands, houfes, &c. materials for employing the poor, and competent fums for their relief. Notice fhall be given in church of every fuch rate the next Sunday after it is allowed, which may be infpected by every inhabitant, paying 1 s. and copies of it granted on demand, 6d. being paid for every 24 names; and a churchwarden or overfeer refufing, fhall forfeit 20 l. to the party aggrieved. The

Poor.

rate is to be levied by diftrefs on thofe who refufe to pay it; and, by 17 Geo. II. cap. 2. cap. 38. appeals againft it are allowed.

If the juftices find that the inhabitants of any parifh are not able to levy among themfelves fufficient fums for the purpofes fpecified in the act, they may affefs any other parifh within the hundred; and if the hundred be unable to grant neceffary relief, they may rate and affefs any parifh within the county. 43 Eliz. cap. 2.

In order to compel hufbands and parents to maintain their own families, the law hath provided, that all perfons running away out of their parifhes, and leaving their families upon the parifh, fhall be deemed and fuffer as incorrigible rogues (7 Jac. cap. 4.) And if a perfon merely threatens to run away and leave his wife and children upon the parifh, he fhall, upon conviction, before one juftice by confeffion, or oath of one witnefs, be committed to the houfe of correction for any time not exceeding one month. (17 Geo. II. cap. 5.) For the farther maintenance of the poor, there are many fines and forfeitures payable to their ufe; as for fwearing, drunkennefs, deftroying the game, &c. And alfo parts of waftes, woods, and paftures, may be inclofed for the growth and prefervation of timber and underwood for their relief. See *Work-Houfe*.

The famous ftatute of the 43d of Elizabeth, which is the bafis of all the poor-laws in England, was conftructed with a cautious forethought that can perhaps be equalled by few laws that ever were enacted; and if profpective reafoning alone were to be relied on in matters of legiflation, it feemed impoffible to amend it: yet experience has now proved, with a moft demonftrative certainty, that it is not fo falutary as was undoubtedly expected.

The perfons who compofed that law had before their eyes fuch a recent proof of the abufe that had been made of the charitable beneficence of individuals, that they feem to have been chiefly folicitous to obviate fimilar abufes in future; and to guard againft that partial kind of feduction, they rather chofe to eftablifh a defpotic power which fhould be authorifed to wreft from every individual in the nation whatever fums it might think proper to call for, trufting to a few feeble devices which they contrived, for curbing that power which was virtually armed with force fufficient to fet all thefe afide whenever it pleafed. The confequence has been, that the fums levied for the relief of the poor, which were at firft but fmall, are now enormous, and that the demands are increafing in fuch a rapid manner as to give rife to the moft ferious and well-grounded apprehenfions. In the year 1774, parliament inftituted an inquiry into the amount of the poor's-rates in England and Wales, and again in 1783. On comparing thefe together, the rife during that fhort period was found to be in England upwards of 850,000 l. *per annum*, being nearly in the proportion of one-third of the rate at the firft period. In Wales, during the fame period of time, the rates were more than doubled. Nor was this a temporary ftart, but a part only of a gradual progreffion. Mr Wenderdon, in his View of England, obferves, that "in the year 1680 the poor's-rates produced no more than 665,390l. in 1764 they ftood at 1,200,000 l. and in 1773 they were eftimated at 3,000,000 l." It is a known fact (fays Mr Beaufoy, in the debate on Mr Gilbert's poor bill, April 17th 1788), that within the laft nine years, the poor's-rates have increafed one-third, and fhould they continue increafing in the fame proportion for 50 or 53 years, they would amount to the enormous fum of 11,230,000 l. a burden which the country could not poffibly bear. It was therefore, he added, highly neceffary that fomething fhould be attempted to prevent this alarming addition, if not to annihilate the prefent glaring mifconduct in the management of the poor."

Poor.

Such has been the fate of England with regard to poor laws.

In Scotland, the reformation having been carried forward with a ftill more violent precipitancy than in England, and the funds of the regular clergy being more entirely alienated, the cafe of the poor there became ftill more feemingly defperate, and the clamours were alfo there confiderable at that time. Then alfo it was that the Scottifh court, imitating as ufual at that time the practice of England, made feveral feeble attempts to introduce a fyftem of compulfory poor's-rates into that country, but never digefted the fyftem fo thoroughly as to form a law that could in any cafe be carried into effect. Many crude laws on this head were indeed enacted; but all of them fo evidently inadequate for the purpofe, that they never were, even in one inftance that we have heard of, attempted at the time to be carried into effect. Indeed it feems to have been impoffible to carry them into effect; for they are all fo abfurd and contradictory to each other, that hardly a fingle claufe of any one of them can be obeyed without tranfgreffing others of equal importance.

The laft ftatute which in Scotland was enacted on this fubject bears date September 1ft 1691, William and Mary, parl. 1. feff. 7. chap. 21. and it "ratifies and approves *all* former acts of parliament and proclamations of council for repreffing of beggars, and maintaining and employing the poor." If this law therefore were now in force, and it never was repealed, no perfon could with impunity countervail any one of thofe ftatutes which it ratifies; but to be convinced how impoffible it is to obferve them all, the attentive reader needs only to confider thofe laws and proclamations with refpect to the following particulars, *viz.*

1. *The perfons appointed to make up the poor's roll.* By the act 1579 this duty is entrufted to the provoft and bailies within burgh, and the judge conftitute be the king's commiffion in paroches to landwart. By act 1663, it is the heritors of each parifh. By act 1672, it is the minifters and elders of each parifh who are to make up this lift. By the proclamation of 1692, it is the heritors, minifters, and elders of every parifh. By that of 1693, it is the magiftrates of royal burghs, and the heritors of vacant [country] parifhes; in both cafes without either minifter or elders. Among this chaos of contradictions how is it poffible to act without tranfgreffing fome law.

2. Not lefs contradictory are the enactments in regard *to the perfons who are to pay*, and the mode of apportioning the fums among them. By act 1579, the haill inhabitants of the parochin fhall be taxed and ftented according to the eftimation of their fubftance, without exception of perfons. By that of 1663, the one-half is to be paid by the heritors, and the other half by the tenants and poffeffors, according to their means and fubftance. By the proclamation of 1692, the one-half is

Poor.

to be paid by the heritors, the other by the houfeholders of the parifh. By that of 1693, in burghs royal, the magiftrates are to ftent themfelves, conform to fuch order and cuftom ufed and wont in laying on ftents, annuities, or other public burdens, in the refpective burgh, as may be moft effectual to reach all the inhabitants; and the heritors of feveral vacant [landwart] parifhes to ftent themfelves for the maintenance of the refpective poor.

3. A ftill greater diverfity takes place in regard to the *application of the fums fo ftented.* By the act 1579, it would feem that the whole of the money affeffed was to be applied to the ufe of the helplefs poor alone, and no part of it for the relief of thofe who were capable of working. By the act 1663, on the contrary, the whole of this affeffment is to be applied for the fupport of thofe *only who are able to work.* This is ftill more fpecially provided for by the act 1672; where the poor who are unable to work are to be fupported by the weekly collections at the kirk doors; and the ftented affeffments to be applied to the fupport of thofe in the correction houfes.

It would be tirefome to enumerate all the contradictions that thefe laws authorife. In regard *to the perfons who are required to carry thefe acts into execution.* it is at different times the chancellor; magiftrates; commiffioners of excife; fheriffs; juftices of the peace; minifters and elders; the prefbyteries; heritors, minifters, and elders; heritors alone; commiffioners nominated by prefbyteries and appointed by the king; the lords of the privy council: in fhort, no two laws can be found that do not vary from each other in this refpect one way or other.

The fame variations take place with regard to the building of correction-houfes, confinement and punifhment of vagrants, application of their work, awarding their fervices and thofe of children. In fhort, there is not one particular in which thefe laws do not vary from and contradict each other; fo that, let any perfon try to act in virtue of any one of them, it is impoffible for him to avoid going in direct oppofition to the enactments of fome other law which is of equal force with that he has chofen for his guide. In thefe circumftances, it is fo far from being furprifing that thefe acts have been fuffered to remain in perpetual defuetude, that it would have been truly wonderful if this had not been the cafe. They have, however, been permitted to remain on the ftatute-book as a difgrace to the times when they were formed, and as a ftumbling-block to thofe that were to follow. That not one of them is now in force was lately proved by a learned and public-fpirited gentleman, to whom his country is on that and many other accounts deeply indebted. Refufing to pay the poor's tax, with which he was affeffed by the overfeers of the parifh in which he happened to refide, he ftood an action in the court of feffion, and prevailed, upon the broad ground, *that there is no law* IN FORCE *in Scotland by which an* INVOLUNTARY *poor's rate can be eftablifhed in any parifh.*

But how, it will be afked by our Englifh readers, are the poor in Scotland really maintained? We anfwer, by the private alms of individuals, and by certain funds under the management of the *kirk-feffions* (fee PRESBYTERIANS). It is the univerfal practice, each Lord's day, in every parifh, for fuch of the audience as are in eafy circumftances, to give to the poor fuch an offering of alms as they fhall deem proper. This offering is generally dropped into a bafon placed at the church-door, and under the immediate care of an elder. When the fervice is begun, the elder removes with the bafon, which he keeps under his charge till the congregation be difmiffed. The feffion then meets, and the money is told over, its amount marked down in the feffion account book, and depofited in a box kept for that purpofe. This box has ufually a fmall flit in the top, through which the pieces of money can be dropped without opening it; and it is clofed with two locks, the key of one of which is ufually kept by the minifter and the other by the kirk-treafurer, fo that it can never be opened but in the prefence of thefe two at leaft.

A kirk-feffion, when regularly conftituted, muft always confift of the minifter, elders, feffion-clerk, and kirk-treafurer. None of thefe ever receive any falary except the feffion-clerk, who is ufually the fchoolmafter of the parifh, and has a fmall falary allowed for minuting the tranfactions. The kirk-treafurer is for the moft part one of the elders; and he is an important member of this court. Without his intervention no diftribution of the poor's funds is deemed legal; nor can any payments be made, receipts granted, or money transferred, but by him; the minifter and feffion being perfonally liable to make good all money that may otherwife be given away, fhould it ever afterwards be challenged by any heritor in the parifh.

The precautions taken for the diftribution of the poor's funds are likewife fimple and excellent, and are as follow.

No money can be legally iffued from the poor's funds even by the treafurer and feffion, unlefs legal proof can be brought that public intimation has been given from the pulpit immediately after divine fervice, and before the congregation has difperfed, that a diftribution of poor's money is to be made by the feffion, at fuch a time and place, fpecifying the fame, and inviting all who have intereft in the cafe to attend if they fhall incline. This intimation muft be made a full fortnight before the time of diftribution; and as every heritor (owner of landed property) in the parifh has a right to vote in the diftribution of the poor's funds, they may all, if they fo incline, then attend and exercife that right: but if none of them fhould attend, which is often the cafe, the feffion has then a right to proceed; and whatever they fhall thus do, is deemed ftrictly legal, and is liable to no challenge. But fhould they proceed without having given this previous intimation, they may, if the heritors fhould afterwards challenge it, be made to repay out of their own pockets every fhilling they fhall have fo iffued. It fometimes happens, that young minifters, through heedlefsnefs in this refpect, expofe themfelves and families to confiderable trouble and lofs, which by attention might be eafily avoided. In the fame way, fhould a minifter and feffion, without the intervention of a treafurer regularly conftituted, lend upon bond or otherwife any of the poor's funds, and fhould the perfon fo borrowing afterwards fail, thefe lenders are perfonally liable to make good the whole, and any heritor in the parifh who chooses it can compel him to do fo.

The members of the feffion are alfo liable to pay all loffes, and to account for all fums that it can be in-

ftructed they received, if they neglect to keep regular books, in which every tranfaction fhall be entered: Or, if thefe books have not been revifed and approved of by the prefbytery (A); but if they fhall have been fo revifed, they cannot be challenged for omiffion of forms, and can only be made to account for errors, or frauds, or evident dilapidations.

Under this wife and economical fyftem of management, it has been found by the experience of more than 200 years, that in the low parts of the country, where the parifhes are in general of fuch moderate extent as to admit of the people of every part of the parifh generally to attend divine fervice every Lord's day, the ordinary funds have been amply fufficient to fupply all the real demands of the poor, and in moft parifhes a fund has been accumulated from the favings of ordinary years to help the deficiencies that may arife in years of uncommon fcarcity.

Befides the weekly collections, the extra offerings at the adminiftration of the Lord's fupper, the pious donations of charitable individuals, which are all voluntary, together with fome fmall fees paid for the ufe of a *mortcloth* (a black velvet pall) at funerals, which is generally purchafed with the poor's money, go to make up this parochial fund. Nor muft any one believe that the money which comes through the hands of the adminiftrators of the poor's funds is all that is beftowed upon the poor in Scotland; far from it: there are a thoufand other channels through which the indigent derive confolation and fupport, all of them tending to produce the happieft effects upon fociety. A fon feels himfelf afhamed to think that his parents fhould require the affiftance of another to fupport them; he therefore ftrains every nerve when in the vigour of life to fpare a little of his earning to render their old age more eafy than it might have been; and fweet to a parent is the bread that is given by the pious attention of a child. If there are feveral children, they become emulous who fhall difcover moft kindnefs. It is a pious contention which ferves to unite them the clofer to each other, by commanding their mutual efteem.

Directly contrary to this is the effect of the poor laws of England, where, in London at leaft, it is not uncommon to fee men in good bufinefs neglecting their aged and difeafed parents for no better reafon than that the parifh is bound to find them bread. Thefe laws have other pernicious confequences; for they are obvioufly fubverfive of induftry as well as morality among the lower orders of the people. "This is a heavy charge, but no lefs true than heavy. Fear of want is the only effectual motive to induftry with the labouring poor: remove that fear, and they ceafe to be induftrious. The ruling paffion of thofe who live by bodily labour, is to fave a pittance for their children, and for fupporting themfelves in old age. Stimulated by defire of accomplifhing thofe ends, they are frugal and induftrious: and the profpect of fuccefs is a continual feaft to them. Now, what worfe can malice invent againft fuch a man, under colour of friendfhip, than to fecure bread to him and his children whenever he takes a diflike to work; which effectually deadens his fole ambition, and with it his honeft induftry? Relying on the certainty of a provifion againft want, he relaxes gradually till he finks into idlenefs; idlenefs leads to profligacy; profligacy begets difeafes; and the wretch becomes an object of public charity before he has run half his courfe. Wifely therefore is it ordered by Providence, that charity fhould in every inftance be voluntary, to prevent the idle and profligate from depending on it for fupport. During the reign of Elizabeth, when the monafteries were recently fuppreffed, and all their revenues fquandered, fome compulfion might be neceffary to prevent the poor from ftarving. A temporary provifion for this purpofe, fo contrived as not to fuperfede voluntary charity, but rather to promote it, would have been a meafure extremely proper. 'Unlucky it is for England that fuch a meafure was overlooked; but the queen and her parliaments had not the talent of forefeeing confequences without the aid of experience. A perpetual tax for the poor was impofed, the moft pernicious tax, fays Lord Kames (B), that ever was impofed in any country."

POPA-MADRE, is a town of South America, in Terra Firma. In this place there is a convent and chapel dedicated to the Virgin Mary, to whofe image the Spaniards in thofe parts go in pilgrimage, particularly thofe who have been at fea. It is feated on a high mountain, 50 miles eaft of Carthagena. W. Long. 74. 32. N. Lat. 10. 15.

POPÆ. See VICTIMARIUS.

POPAYAN, a province of South America, in the kingdom of New Granada, between the audience of Panama, that of Quito, and the South Sea; 400 miles in length, and 300 in breadth. A chain of barren mountains runs through the country from north to fouth; and near the fea the foil is fo foaked with almoft continual rains, that few care to refide there, except for the fake of the gold that is met with in great plenty in the fands of the rivulets. This bewitching metal brings many in fearch of it, though it is a great doubt whether they ever return back alive or not. For this reafon the favage Americans are ftill mafters of a great part of it, and continually annoy the Spaniards.

POPAYAN, the capital town of a province of that name in South America, with a bifhop's fee, a Spanifh governor, and where the courts of juftice are held. The inhabitants are almoft all Creoles. It is 220 miles north-eaft of Quito. W. Long. 75. 55. N. Lat. 2. 35.

POPE, a name which comes from the Greek word Παπα, and fignifies *Father*. In the eaft this appellation is given to all Chriftian priefts; and in the weft, bifhops were called by it in ancient times: but now for many

(A) The prefbytery is by law appointed auditor of the poor's accounts of the feveral parifhes within its bounds; and if they find any difficult cafe occur in the difcharge of this duty, they may lay it before the fynod for advice.

(B) See *Sketches of Man*, book ii. fketch 10. where many other arguments equally forcible are urged againft all involuntary *poor-rates*, and where many ingenious expedients are propofed for gradually abolifhing them where they are eftablifhed.

many centuries it has been appropriated to the biſhop of Rome, whom the Roman Catholics look upon as the common father of all Chriſtians.

Much has been ſaid, much written, and many warm diſputes have been carried on concerning the pope, and the power belonging to him, within theſe two or three laſt centuries. We ſhall here, without entering into controverſy, lay down diſtinctly, from the beſt authority, what the Roman Catholics really believe concerning the *pope*, after having deſcribed the manner of his election; and we ſhall give ſome other particulars relating to this ſubject that ſeem to deſerve notice, and are in this country not generally known.

All in communion with the ſee of Rome unanimouſly hold, that our Saviour Jeſus Chriſt conſtituted St Peter the apoſtle chief paſtor under himſelf, to watch over his whole flock here on earth, and to preſerve the unity of it; giving him the power requiſite for theſe ends. They alſo believe, that our Saviour ordained, that St Peter ſhould have ſucceſſors with the like charge and power, to the end of time. Now, as St Peter reſided at Rome for many years, and ſuffered martyrdom there, they conſider the biſhops of Rome as his ſucceſſors in the dignity and office of the univerſal paſtor of the whole Catholic church. There have been ſome varieties in the manner of chooſing the biſhop of Rome in different ages, as alterations may be made in diſcipline; but ſtill the clergy of Rome have juſtly had the chief part in that election: and that clergy is now repreſented by, or in ſome manner conſiſts of, *the cardinals*, who have for ſeveral centuries been the ſole electors of the pope.

Theſe *cardinals* or *principal perſons* of the church of Rome are 70 in number, when the *ſacred college*, as it is called, is complete. Of theſe ſix are cardinal biſhops, the biſhops of Oſtia, of Porto, Albano, Sabino, Tuſculum or Fraſcati, and Prænefte or Paleſtrina; which are the ſix ſuburbicarian churches; fifty are cardinal prieſts, who have all titles from pariſh churches in Rome; and fourteen are cardinal deacons, who have their titles from churches in Rome of leſs note, called *Diaconias* or *Deaconries*. Theſe cardinals are created by the pope when there happen to be vacancies; and ſometimes he names one or two only at a time; but commonly he defers the promotion until there be ten or twelve vacancies or more; and then at every ſecond ſuch promotion the emperor, the kings of Spain and France, and of Britain, when Catholic, are allowed to preſent one each, to be made cardinal, whom the pope always admits if there be not ſome very great and evident objection. Theſe cardinals are commonly promoted from among ſuch clergymen as have borne offices in the Roman court; ſome are aſſumed from religious orders; eminent eccleſiaſtics of other countries are likewiſe often honoured with this dignity, as the archbiſhops of Toledo and Vienna are at preſent cardinal prieſts of Rome. Sons of ſovereign princes have frequently been members of the ſacred college; and there ends the direct line of the royal family of Stuart. Their diſtinctive dreſs is ſcarlet, to ſignify that they ought to be ready to ſhed their blood for the faith and church, when the defence and honour of either require it. They wear a ſcarlet cap and hat: the cap is given to them by the pope if they are at Rome, and is ſent to them if they are abſent; but the hat is never given but by the pope's own hand. Theſe cardinals form the pope's ſtanding council or *conſiſtory* for the management of the public affairs of church and ſtate. They are divided into different *congregations* for the more eaſy diſpatch of buſineſs; and ſome of them have the principal offices in the pontifical court, as that of cardinal-vicar—penitentiary—chancellor—camerlingo or chamberlain—prefect of the ſignature of juſtice—prefect of memorials—and ſecretary of ſtate. They have the title given them of *eminence* and *moſt eminent*. But here we conſider them principally as the perſons entruſted with the choice of the pope. See Cardinal.

On the demiſe of a pope his pontifical ſeal is immediately broken by the chamberlain, and all public buſineſs is interrupted that can be delayed: meſſengers are diſpatched to all the Catholic ſovereigns to acquaint them of the event, that they may take what meaſures they think proper; and that the cardinals in their dominions, if any there be, may haſten to the future election if they chooſe to attend; whilſt the whole attention of the ſacred college is turned to the preſervation of tranquillity in the city and ſtate, and to the neceſſary preparations for the future election. The cardinal chamberlain has, during the vacancy of the holy ſee, great authority; he coins money with his own arms on it, lodges in the pope's apartments, and is attended by body-guards. He, and the firſt cardinal biſhop, the firſt cardinal prieſt, and the firſt cardinal deacon, have, during that time, the government almoſt entirely in their hands. The body of the deceaſed pope is carried to St Peter's, where funeral ſervice is performed for him with great pomp for nine days, and the cardinals attend there every morning. In the mean time, all neceſſary preparations for the election are made; and the place where they aſſemble for that purpoſe, which is called the *conclave*, is fitted up in that part of the Vatican palace which is neareſt to St Peter's church, as this has long been thought the moſt convenient ſituation. Here is formed by partitions of wood a number of cells or chambers equal to the number of cardinals, with a ſmall diſtance between every two, and a broad gallery before them. A number is put on every cell, and ſmall papers with correſponding numbers are put into a box: every cardinal, or ſome one for him, draws out one of theſe papers, which determines in what cell he is to lodge. The cells are lined with cloth; and there is a part of each one ſeparated for the conclaviſts or attendants, of whom two are allowed to each cardinal, and three to cardinal princes. They are perſons of ſome rank, and generally of great confidence; but they muſt carry in their maſter's meals, ſerve him at table, and perform all the offices of a menial ſervant. Two phyſicians, two ſurgeons, an apothecary, and ſome other neceſſary officers, are choſen for the conclave by the cardinals.

On the 10th day after the pope's death, the cardinals, who are then at Rome, and in a competent ſtate of health, meet in the chapel of St Peter's, which is called the *Gregorian chapel*, where a ſermon on the choice of a pope is preached to them, and maſs is ſaid for invoking the grace of the Holy Ghoſt. Then the cardinals proceed to the conclave in proceſſion two by two, and take up their abode. When all is properly ſettled, the conclave is ſhut up, having boxed *wheels* or places of communication in convenient quarters: there are alſo ſtrong guards placed all around. When any foreign

Pope.

foreign cardinal arrives after the inclofure, the conclave is opened for his admiffion. In the beginning every cardinal figns a paper, containing an obligation, that if he fhall be raifed to the papal chair he will not alienate any part of the pontifical dominion; that he will not be prodigal to his relations; and any other fuch ftipulations as may have been fettled in former times or framed for that occafion.

We come now to the election itfelf; and that this may be effectual, two thirds of the cardinals prefent muft vote for the fame perfon. As this is often not eafily obtained, they fometimes remain whole months in the conclave. They meet in the chapel twice every day for giving their votes; and the election may be effectuated by *fcrutiny*, *acceffion*, or *acclamation*. Scrutiny is the ordinary method; and confifts in this: every cardinal writes his own name on the inner part of a piece of paper, and this is folded up and fealed; on a fecond fold of the fame paper a conclavift writes the name of the perfon for whom his mafter votes. This, according to agreements obferved for fome centuries, muft be one of the facred college. On the outer fide of the paper is written a fentence at random, which the voter muft well remember. Every cardinal, on entering into the chapel, goes to the altar and puts his paper into a large chalice.

When all are convened, two cardinals number the votes; and if there are more or lefs than the number of cardinals prefent, the voting muft be repeated. When that is not the cafe, the cardinal appointed for the purpofe reads the outer fentence, and the name of the cardinal under it, fo that each voter hearing his own fentence and the name joined with it, knows that there is no miftake. The names of all the cardinals that are voted for are taken down in writing, with the number of votes for each; and when it appears that any one has two-thirds of the number prefent in his favour the election is over: but when this does not happen, the voting papers are all immediately burnt without opening up the inner part. When feveral trials of coming to a conclufion by this method of *fcrutiny* have been made in vain, recourfe is fometimes had to what is called *acceffion*. By it, when a cardinal perceives that one or very few votes are wanting to any one for whom he had not voted at that time, he may fay that he *accedes* to the one who has near the number of votes requifite; and if his one vote fuffices to make up the two-thirds, or if he is followed by a fufficient number of *acceders* or new voters for the faid cardinal, the election is accomplifhed. Laftly, a pope is fometimes elected by *acclamation*; and that is, when a cardinal, being pretty fure that he will be joined by a number fufficient, cries out in the open chapel, that fuch an one fhall be pope. If he is fupported properly, the election becomes unanimous; thofe who would perhaps oppofe it forefeeing that their oppofition would be fruitlefs, and rather hurtful to themfelves. It is to be obferved, that the emperor of Germany and the kings of France and Spain claim a right of excluding one cardinal from being pope at every election. Hence, when the ambaffador at Rome of any of thefe fovereigns perceives that any cardinal, difagreeable to his mafter, according to the inftructions he has received, is like to be made pope, he demands an audience of the conclave, is admitted, and there declares his mafter's will, which is always attended to for the common good. But each of thofe fovereigns is allowed thus to exclude only one at one time; and they unwillingly and feldom put this right in execution.

When a pope is chofen in any of the three abovementioned ways, the election is immediately announced from the balcony in the front of St Peter's, homage is paid to the new pontiff, and couriers are fent off with the news to all parts of Chriftendom. The pope appoints a day for his coronation at St Peter's, and for his taking poffeffion of the patriarchal church of St John Lateran; all which is performed with great folemnity. He is addreffed by the expreffion of *Holinefs*, and *moft holy Father*.

Let us now proceed to fee what authority Roman Catholics attribute to the pope thus chofen. They believe, then, that the bifhop of Rome is, under Chrift, fupreme paftor of the whole church; and as fuch is not only the firft bifhop in order and dignity, but has alfo a power and jurifdiction over all Chriftians, in order to preferve unity and purity of faith and moral doctrine, and to maintain order and regularity in all churches. Wherefore they hold, that when the pope underftands that any error has been broached againft faith or manners, or that any confiderable difference on fuch fubjects has arifen in any part of Chriftendom, it belongs to him, after due deliberation and confultation, to iffue out his paftoral decree, condemning the error, clearing up the doubt, and declaring what has been delivered down, and what is to be believed. Some Catholic divines are of opinion that the pope cannot err, when he thus addreffes himfelf *to all the faithful* on matters of doctrine. They well know, that as a private doctor he may fall into miftakes as well as any other man; but they think, that when he teaches the whole church Providence muft preferve him from error; and they apprehend, that this may be deduced from the promifes of Chrift to St Peter, and from the writings of the ancient fathers. However, this infallibility of the pope, even when he pronounces in the moft folemn manner, is only an opinion, and not an article of Roman Catholic faith. Wherefore, when he fends for the doctrinal decrees, the other bifhops, who are alfo guardians of the faith in an inferior degree, may, with due refpect, examine thefe decrees; and if they fee them agree with what has been always taught, they either formally fignify their acceptance, or they tacitly acquiefce, which, confidering their duty, is equivalent to a formal approbation. When the acceptation of the generality of the bifhops has been obtained, either immediately or after fome mutual correfpondence and explanation, the decrees of the pope thus accepted come to be the fentence of the whole church, and are believed to be beyond the poffibility of error!

Sometimes it may happen that the difputes and difference may be fo great and intricate, that to the end it may be feen more clearly what has really been delivered down; and to give all poffible fatisfaction, it may appear proper to convene all the bifhops who can conveniently attend to one place, to learn from them more diftinctly what has been taught and held in their refpective churches. Roman Catholics believe that it belongs to the pope to call fuch general councils, and to prefide in them in perfon or by his legates. They likewife hold, that when the pope has approved the decrees of fuch councils concerning faith or manners, fuch

ſuch decrees are then final, and muſt be received as ſuch by all Catholics. In all this they believe, that the particular aſſiſtance of the Holy Ghoſt is with the paſtors of the church, that ſo *the gates of hell may never prevail againſt her.*

The ſee of Rome, according to Roman Catholics, is the centre of Catholic unity. All their biſhops communicate with the pope, and by his means with one another, and ſo form one body. However diſtant their particular churches may be, they all meet at Rome either in perſon or by their delegates, or at leaſt by their letters. And, according to the diſcipline of the latter ages, though they are preſented to the pope for their office from their reſpective countries, yet from him they muſt receive their bulls of conſecration before they can take poſſeſſion of their ſees.

In matters of church diſcipline, the pope, as chief paſtor, not only ought to take care that the canons actually in force be obſerved in all churches, but he may alſo make new canons and regulations when he ſees it neceſſary or expedient for the ſpiritual benefit of the faithful, according to times and circumſtances. But in doing this he muſt not infringe the eſtabliſhed rights or cuſtoms with injury to any perſon; which if, through miſtake or wrong information, he ſhould ever do, the perſons who think themſelves aggrieved may remonſtrate with reſpect and ſue for redreſs. He may eſtabliſh new epiſcopal ſees, where there have been none before; and he may alter the limits of former dioceſes; but in ſuch alterations he always of courſe conſults the temporal ſovereign, if in communion with him. He ſends paſtors to preach the goſpel to all countries where the Catholic religion is not by law eſtabliſhed; and to him appeals may be made from all parts of Chriſtendom in eccleſiaſtical cauſes of great importance.

The pope may diſpenſe with the obſervation of eccleſiaſtical canons when there are juſt reaſons for it, as may frequently happen; he may alſo diſpenſe with vows when they are made with that expreſs or tacit condition (A) that he really may diſpenſe with them; he may alſo on ſome occaſions declare that obligations have really ceaſed when that is truly the caſe, from a great alteration of circumſtances: But he can never grant any diſpenſation, to the injury of any third perſon, and can never allow any one to do what is unjuſt, or to ſay what he knows to be falſe, whatever advantage might be expected from it.

The pope is alſo a temporal prince, and poſſeſſes conſiderable dominions in the middle part of Italy, beſides Avignon, which the French have lately taken from him, and the duchy of Benevento incloſed within the kingdom of Naples. It is alſo ſuppoſed that the kingdoms of Naples and Sicily, and the duchies of Parma and Placentia, are ſtill held of him in fief as they were before. His predeceſſors have acquired theſe poſſeſſions at different times and on different occaſions, by various donations conceſſions, treaties, and agreements, in like manner as has happened with regard to the eſtabliſhment of other ſovereignties; and his title to them is like to that of other potentates to their reſpective poſſeſſions. The revenue ariſing from this eſtate, and what he receives for various reaſons from Catholic countries, which is now much reduced, is employed for the ſupport of government, in ſalaries to the officers of his court, for the education of clergymen, and for the maintaining of miſſionaries in infidel countries. Great ſums are particularly expended for the propagation of the Chriſtian faith in different parts of Aſia, eſpecially in Armenia, Syria, and China. Nor is it much to be wondered at, if the families, of which the ſovereign pontiffs happen to have been born, acquire greater riches and ſplendor from that connection. The princely families of Barberini, Borgheſe, Chigi, Corſini, Albani, are examples of this kind: but regulations have been made in later times to prevent exceſſive nepotiſm. Beyond the limits of his own temporal dominions the pope has no temporal power or juriſdiction, excepting what any nation may be pleaſed to allow him: when any thing of that kind has been granted or brought in by cuſtom, it is evident that it ought not to be taken away raſhly nor without juſt reaſon. But, as chief paſtor of the church, he has no right to any temporal juriſdiction over his flock. As ſuch, his power is entirely ſpiritual, and has no means of coercion originally or neceſſarily connected with it, but only eccleſiaſtical cenſures. It muſt be owned, that the popes, in ſome ages, ſometimes imagining that they could do much good, ſometimes by the conſent, or even at the deſire, of the ſovereigns, and ſometimes no doubt out of ambitious views, have interfered a great deal in the temporal affairs of the different kingdoms of Europe, which has frequently given ſcandal and done harm to religion. But it is known to thoſe moſt verſant in hiſtory, that their faults of this kind have been exaggerated, and their conduct often miſunderſtood or miſrepreſented. However, in this a Roman Catholic is not obliged to approve what they have done; nay, without acting contrary to his religion, he may judge of them freely, and blame them if he think they deſerve it; only he will do it with reſpect and regret. Thus a Roman Catholic may either apologiſe, if he think he can do it, for the conduct of Innocent III. in depoſing king John of England; or, without being guilty of any offence againſt his religion, he may blame the pontiff for what he did on that occaſion; becauſe the power of the pope to depoſe princes, or to abſolve ſubjects from their allegiance, was never propoſed as an article of faith, or made a term of communion with the church of Rome. Some Catholic divines, indeed, eſpecially among the Jeſuits, are univerſally known to have held this extravagant and dangerous opinion; but by far the greater part of them condemn and abhor it as abſurd and impious: and ſurely it is but fair and juſt to allow them to know beſt what they themſelves believe. And here, to conclude, we ſhall add, that it is very deſirable that Chriſtians of all denominations endeavour to underſtand one another better than they have often done; and inſtead of ſuppoſing imaginary differences, ſtrive to remove real ones, for the general good of mankind, for the glory of God, and honour of religion; and that all vie with one another to excel in juſt and charitable ſentiments, language, and behaviour.

The

(A) Any other man may unqueſtionably do the ſame when they are made with that expreſs condition.

Pope.

The reader, who wishes to know what can be urged for and against the supremacy of the pope, and who is fitted by his knowledge of ecclesiastical history to understand the nature of the question at issue, may consult, on the one hand, the works of Bellarmine, together with a small tract lately published in English, under the title of *The Divine Economy of Christ in his Kingdom or Church;* and on the other, Barrow's treatise *on the Pope's Supremacy*, together with Chillingworth's *Religion of Protestants*, &c.

Pope (Alexander), a celebrated English poet, was descended from good families, and born the 8th of June 1688, at London, where his father was then a considerable merchant. He was taught to read very early by an aunt; and learned to write without any assistance, by copying printed books. The family being of the Romish religion, he was put, at eight years of age, under one Taverner, a priest, who taught him the rudiments of the Latin and Greek tongues together; and soon after was sent to a Popish seminary at Winchester, from whence he was removed to a school at Hyde-Park Corner. He discovered early an inclination to versifying; and the translations of Ogilby and Sandys from Virgil and Ovid first falling in his way, they were his favourite authors. At twelve he retired with his parents to Binfield, in Windsor Forest; and there became acquainted with the writings of Spenser, Waller, and Dryden. Dryden struck him most, probably because the cast of that poet was most congenial with his own; and therefore he not only studied his works intensely, but ever after mentioned him with a kind of rapturous veneration. He once obtained a sight of him at a coffee-house, but never was known to him: a misfortune which he laments in these short but expressive words, *Virgilium tantum vidi*. Though Pope had been under more tutors than one, yet it seems they were so insufficient for the purpose of teaching, that he had learned very little from them: so that, being obliged afterwards to begin all over again, he may justly be considered as one of the αὐτοδίδακτοι or *self-taught*. At fifteen he had acquired a readiness in the two learned languages; to which he soon after added the French and Italian. He had already scribbled a great deal of poetry in various ways; and this year set about an epic poem called *Alcander*. He long after communicated it to Atterbury, with a declared intention to burn it; and that friend concurred with him: "Though (adds he) I would have interceded for the first page, and put it, with your leave, among my curiosities." What the poet himself observes upon these early pieces is agreeable enough; and shows, that though at first a little intoxicated with the waters of Helicon, he afterwards arrived to great sobriety of thinking. "I confess (says he) there was a time when I was in love with myself; and my first productions were the children of Self-love upon Innocence. I had made an epic poem, and panegyrics on all the princes; and I thought myself the greatest genius that ever was. I cannot but regret these delightful visions of my childhood, which, like the fine colours we see when our eyes are shut, are vanished for ever." His pastorals, begun in 1704, first introduced him to the wits of the time; among which were Wycherly and Walsh. This last gentleman proved a sincere friend to him; and soon discerning that his talent lay, not so much in striking out new thoughts of his own, as in improving those of other men, and in an easy versification, told him, among other things, that there was one way left open for him to excel his predecessors in, which was correctness: observing, that though we had several great poets, yet none of them were correct. Pope took the hint, and turned it to good account; for no doubt the distinguishing harmony of his numbers was in a great measure owing to it. The same year, 1704, he wrote the first part of his Windsor Forest, though the whole was not published till 1710. In 1708, he wrote the Essay on Criticism; which production was justly esteemed a masterpiece in its kind, and showed not only the peculiar turn of his talents, but that those talents, young as he was, were ripened into perfection. He was not yet twenty years old; and yet the maturity of judgment, the knowledge of the world, and the penetration into human nature, displayed in that piece, were such as would have done honour to the greatest abilities and experience. But whatever may be the merit of the Essay on Criticism, it was still surpassed, in a poetical view, by the Rape of the Lock, first completely published in 1712. The former excelled in the didactic way, for which he was peculiarly formed; a clear head, strong sense, and a sound judgment, being his characteristical qualities; but it is the creative power of the imagination that constitutes what is properly called a *poet;* and therefore it is in the Rape of the Lock that Pope principally appears one, there being more *vis imaginandi* displayed in this poem than perhaps in all his other works put together. In 1713, he gave out proposals for publishing a translation of Homer's Iliad, by subscription; in which all parties concurred so heartily, that he acquired a considerable fortune by it. The subscription amounted to 6000 l. besides 1200 l. which Lintot the bookseller gave him for the copy. Pope's finances being now in good condition, he purchased a house at Twickenham, whither he removed with his father and mother in 1715: where the former died about two years after. As he was a Papist, he could not purchase, nor put his money to interest on real security; and as he adhered to the cause of King James, he made it a point of conscience not to lend it to the new government; so that, though he was worth near 20,000 l. when he laid aside business, yet, living afterwards upon the quick stock, he left but a slender subsistance to his family. Our poet, however, did not fail to improve it to the utmost: he had already acquired much by his publications, and he was all attention to acquire more. In 1717, he published a collection of all he had printed separately; and proceeded to give a new edition of Shakespeare; which, being published in 1721, discovered that he had consulted his fortune more than his fame in that undertaking. The Iliad being finished, he engaged upon the like footing to undertake the Odyssey. Mr Broome and Mr Fenton did part of it, and received 500l. of Mr Pope for their labours. It was published in the same manner, and on the same conditions to Lintot; excepting that, instead of 1200l. he had but 600l. for the copy. This work being finished in 1725, he was afterwards employed with Swift and Arbuthnot in printing some volumes of Miscellanies. About this time he narrowly escaped losing his life, as he was returning home in a friend's chariot; which, on passing a bridge, happened to be overturned, and thrown with the horses into the river.

Pope.

The glasses were up, and he was not able to break them: so that he had immediately been drowned, if the postilion had not broke them, and dragged him out to the bank. A fragment of the glass, however, cut him so desperately, that he ever after lost the use of two of his fingers. In 1727 his Dunciad appeared in Ireland; and the year after in England, with notes by Swift, under the name of *Scriblerus*. This edition was presented to the king and queen by Sir Robert Walpole; who, probably about this time, offered to procure Pope a pension, which however he refused, as he had formerly done a proposal of the same kind made him by Lord Halifax. He greatly cultivated the spirit of independency; and "Unplac'd, unpension'd, no man's heir or slave," was frequently his boast. He somewhere observes, that the life of an author is a state of warfare: he has shown himself a complete general in this way of warring. He bore the insults and injuries of his enemies long; but at length, in the Dunciad, made an absolutely universal slaughter of them: for even Cibber, who was afterwards advanced to be the hero of it, could not forbear owning, that nothing was ever more perfect and finished in its kind than this poem. In 1729, by the advice of Lord Bolingbroke, he turned his pen to subjects of morality; and accordingly we find him, with the assistance of that noble friend, who furnished him with the materials, at work this year upon the Essay on Man. The following extract of a letter to Swift discovers the reason of his Lordship's advice: "Bid him (says Bolingbroke) talk to you of the work he is about, I hope in good earnest; it is a fine one, and will be, in his hands, an original. His sole complaint is, that he finds it too easy in the execution. This flatters his laziness: it flatters my judgement; who always thought, that, universal as his talents are, this is eminently and peculiarly his, above all the writers I know, living or dead; I do not except Horace." Pope tells the dean in the next letter, that "the work Lord Bolingbroke speaks of with such abundant partiality, is a system of ethics, in the Horatian way." In pursuing the same design, he wrote his Ethic Epistles: the fourth of which, upon Taste, giving great offence, as he was supposed to ridicule the duke of Chandos under the character of Timon, is said to have put him upon writing satires, which he continued till 1739. He ventured to attack persons of the highest rank, and set no bounds to his satirical rage. A genuine collection of his letters was published in 1737. In 1738, a French translation of the Essay on Man, by the Abbé Resnel, was printed at Paris; and Mr Crousaz, a German professor, animadverted upon this system of ethics, which he represented as nothing else but a system of naturalism. Mr Warburton, afterwards bishop of Gloucester, wrote a commentary upon the Essay; in which he defends it against Crousaz, whose objections he supposes owing to the faultiness of the Abbé Resnel's translation. The poem was republished in 1740, with the commentary. Our author now added a fourth book to the Dunciad, which was first printed separately in 1742: but the year after, the whole poem came out together, as a specimen of a more correct edition of his works. He had made some progress in that design, but did not live to complete it. He had all his life long been subject to the head-ach; and that complaint, which he derived from his mother, was now greatly increased by a dropsy in his breast, under which he expired the 30th of May 1744, in the 56th year of his age. In his will, dated December 12, 1743, Miss Blount, a lady to whom he was always devoted, was made his heir during her life: and among other legacies, he bequeathed to Mr Warburton the property of all such of his works, already printed, as he had written, or should write commentaries upon, and which had not otherwise been disposed of or alienated; with this condition, that they were published without future alterations. In discharge of this trust, that gentleman gave a complete edition of all Mr Pope's works, 1751, in 9 vols, 8vo. A work, entitled, *An Essay on the Writings and Genius of Pope*, by Mr Warton, 2 vols 8vo, will be read with pleasure by those who desire to know more of the person, character, and writings of this excellent poet. Lord Orrery's account of him is very flattering: "If we may judge of him by his works (says this noble author), his chief aim was to be esteemed a man of virtue. His letters are written in that style; his last volumes are all of the moral kind; he has avoided trifles, and consequently has escaped a rock which has proved very injurious to Swift's reputation. He has given his imagination full scope, and yet has preserved a perpetual guard upon his conduct. The constitution of his body and mind might really incline him to the habits of caution and reserve. The treatment which he met with afterwards, from an innumerable tribe of adversaries, confirmed this habit; and made him slower than the dean in pronouncing his judgment upon persons and things. His prose-writings are little less harmonious than his verse; and his voice, in common conversation, was so naturally musical, that I remember honest Tom Southern used to call him the *little nightingale*. His manners were delicate, easy, and engaging; and he treated his friends with a politeness that charmed, and a generosity that was much to his honour. Every guest was made happy within his doors; pleasure dwelt under his roof, and elegance presided at his table."

Yet, from Dr Johnson's account of his domestic habits, we have reason to doubt the latter part of this character. His parsimony (he informs us) appeared in very petty matters, such as writing his compositions on the backs of letters, or in a niggardly reception of his friends, and a scantiness of entertainment—as the setting a single pint on the table to two friends, when, having himself taken two small glasses, he would retire, saying, I leave you to your wine. He sometimes, however, the Doctor acknowledges, made a splendid dinner; but this happened seldom. He was very full of his fortune, and frequently ridiculed poverty; and he seems to have been of an opinion not very uncommon in the world, that to want money is to want every thing. He was almost equally proud of his connection with the great, and often boasted that he obtained their notice by no meanness or servility. This admiration of the great increased in the advance of life; yet we must acknowledge, that he could derive but little honour from the notice of Cobham, Burlington, or Bolingbroke.

By natural deformity, or accidental distortion, his vital functions were so much disordered, that his life was a long disease; and from this cause arose many of his peculiarities and weaknesses. He stood constantly in

in need of female attendance; and to avoid cold, of which he was very fenfible, he wore a fur doublet under his fhirt, &c. The indulgence and accommodation which his ficknefs required, had taught him all the unpleafing and unfocial qualities of a valetudinary man.—When he wanted to fleep, he nodded in company; and once flumbered at his own table when the prince of Wales was talking of poetry. He was extremely troublefome to fuch of his friends as afked him out, which many of them frequently did, and plagued the fervants beyond defcription. His love of eating is another fault to which he is faid to have fallen a facrifice. In all his intercourfe with mankind, he had great delight in artifice, and endeavoured to attain all his purpofes by indirect and unfufpected methods.

In familiar converfation it is faid he never excelled; and he was fo fretful and fo eafily difpleafed, that he would fometimes leave Lord Oxford's filently without any apparent reafon, and was to be courted back by more letters and meffages than the fervants were willing to carry.

Dr Johnfon alfo gives a view of the intellectual character of Pope, and draws a parallel between Dryden and him. For particulars, however, we muft refer our readers to *Johnfon's Lives of the Poets.*

Pope's *Dominions*, or *Ecclefiaftical States*, a country of Italy, bounded on the north by the gulph of Venice and the Venetian dominions, on the fouth by the Mediterranean, on the eaft by the kingdom of Naples and the Adriatic, and on the weft by Tufcany and Modena. It is 400 miles long on the coaft of the Adriatic from Naples to the Venetian territory. It is but narrow, however, from north to fouth, not being more than 80 miles broad from the gulph of Venice to the Tufcan fea.

The foil, in general, of the pope's dominions is very fertile, but ill cultivated; and there are many fens and marfhy grounds which are very prejudicial to the air. That the lands are badly cultivated and inhabited, the air bad, and the inhabitants poor, idle, lazy, and grofsly fuperftitious, is owing to a variety of caufes. With refpect to the accommodations of life, this country is but in a very indifferent condition; for, notwithftanding the fertility of its foil, its advantageous fituation for traffic, the large fums fpent in it by travellers, or remitted to it from foreign countries, and its having, for its ruler, the fucceffor of St Peter, the prince of the apoftles, and the vicar of Jefus Chrift; yet it is poor and thin of inhabitants, ill cultivated, and without trade and manufactures. This is partly owing to the great number of holidays, of fturdy beggars called *pilgrims*, and of hofpitals and convents, with the amazing but perhaps ufelefs wealth of churches and convents, and the inquifition: but the chief caufe is the feverity of the government, and the grievous exactions and hardfhips to which the fubjects are expofed. The legates, though moftly clergymen, whofe thoughts fhould be chiefly employed about laying up treafures in heaven, and who ought to fet an example to the laity of difintereftednefs and a contempt of this world, too often, it is faid, fcruple no kind of rapacioufnefs: even the holy father himfelf, and the cardinals, frequently make the enriching of their nephews and other relations, and the aggrandizing their families, too much the bufinefs of their lives. The extenfive claims and great pretenfions of the pope are well known, and by a large part of Chriftendom, are now treated with contempt and mockery. The Reformation gave a great blow to his fpiritual power; and the French revolution has leffened it ftill more. His temporal dominions, however, ftill continue much the fame; though how long this may be the cafe, confidering how much he hath loft, and is daily lofing, of his ghoftly empire, and the veneration in which he was formerly held, it is difficult to fay. See Pope, p. 378. col. 1.—The Campania of Rome is under the pope's immediate government; but the other provinces are governed by legates and vice-legates, and there is a commander in chief of the pope's forces in every province. The pope is chofen by the cardinals in the conclave: See this particularly defcribed under Pope. The pope holds a confiftory of cardinals on ecclefiaftical affairs; but the cardinals do not meddle with his civil government. The pope's chief minifter is the cardinal-patron, ufually his nephew, who amaffes an immenfe eftate, if the reign be of any long duration. The cardinal that is chofen pope muft generally be an Italian, and at leaft 55 years of age. The fpiritual power of the pope, though far fhort of what it was before the Reformation, is ftill confiderable. It is computed that the monks and regular clergy, who are abfolutely at his devotion, do not amount to lefs than 2,000,000 of people, difperfed through all the Roman Catholic countries, to affert his fupremacy over princes, and promote the intereft of the church. The revenues of thefe monks do not fall fhort of L. 20,000,000 Sterling, befides the cafual profits arifing from offerings, and the people's bounty to the church, who are taught that their falvation depends on this kind of benevolence.

The pope's revenues, as a temporal prince, may amount to about L. 1,000,000 Sterling *per annum*, arifing chiefly from the monopoly of corn, the duties on wine and other provifions. Over and above thefe, vaft fums are continually flowing into the papal treafury from all the Roman Catholic countries, for difpenfations, indulgences, canonizations, annates, the pallia, and inveftitures of archbifhops, bifhops, &c.

The pope has a confiderable body of regular forces, well clothed and paid; but his fleet confifts only of a few galleys. His life-guards are 40 Switzers, 75 cuiraffiers, and as many light horfe. Since the beginning of this war, we are told, he has likewife had a guard of Englifh horfe.

POPERY, in ecclefiaftical hiftory, comprehends the religious doctrines and practices adopted and maintained by the church of Rome. The following fummary, extracted chiefly from the decrees of the council of Trent, continued under Paul III. Julius III. and Pius IV. from the year 1545 to 1563, by fucceffive feffions, and the creed of pope Pius IV. fubjoined to it, and bearing date November 1564, may not be unacceptable to the reader. One of the fundamental tenets, ftrenuoufly maintained by popifh writers, is the infallibility of the church of Rome; though they are not agreed whether this privilege belongs to the pope or a general council, or to both united; but they pretend that an infallible living judge is abfolutely neceffary to determine controverfies, and to fecure peace in the Chriftian church. However, Proteftants allege, that the claim of infallibility in any church is not juftified

Popery. by the authority of Scripture; much lefs does it pertain to the church of Rome; and that it is inconfiftent with the nature of religion, and the perfonal obligations of its profeffors; and that it has proved ineffectual to the end for which it is fuppofed to be granted, fince popes and councils have difagreed in matters of importance, and they have been incapable, with the advantage of this pretended infallibity, of maintaining union and peace.

Another effential article of the popifh creed is the fupremacy of the pope, or his fovereign power over the univerfal church. See Pope.

Farther, the doctrine of the feven facraments is a peculiar and diftinguifhing doctrine of the church of Rome: thefe are baptifm, confirmation, the euchariſt, penance, extreme unction, orders, and matrimony.

The council of Trent (feff. 7. can. 1.) pronounces an anathema on thofe who fay, that the facraments are more or fewer than feven, or that any one of the above number is not truly and properly a facrament. And yet it does not appear that they amounted to this number before the 12th century, when Hugo de St Victore and Peter Lombard, about the year 1144, taught that there were feven facraments. The council of Florence, held in 1438, was the firft council that determined this number. Thefe facraments confer grace, according to the decree of the council of Trent (fef. 7. can. 8.) *ex opere operato*, by the mere adminiftration of them: three of them, viz. baptifm, confirmation, and orders, are faid (can. 9.) to imprefs an indelible character, fo that they cannot be repeated without facrilege; and the efficacy of every facrament depends on the intention of the prieft by whom it is adminiftered (can. 11.) Pope Pius exprefsly enjoins, that all thefe facraments fhould be adminiftered according to the received and approved rites of the Catholic church. With regard to the euchariſt in particular, we may here obferve, that the church of Rome holds the doctrine of tranfubftantiation; the neceffity of paying divine worfhip to Chrift under the form of the confecrated bread, or hoft; the propitiatory facrifice of the mafs, according to their ideas of which Chrift is truly and properly offered as a facrifice as often as the prieft fays mafs; it practifes likewife folitary mafs, in which the prieft alone, who confecrates, communicates, and allows communion only in one kind, viz. the bread, to the laity. Seff. 14.

The doctrine of merits is another diftinguifhing tenet of popery; with regard to which the council of Trent has exprefsly decreed (feff. 6. can. 32.) that the good works of juftified perfons are truly meritorious; deferving not only an increafe of grace, but eternal life, and an increafe of glory; and it has anathematized all who deny this doctrine. Of the fame kind is the doctrine of fatisfactions; which fuppofes that penitents may truly fatisfy, by the afflictions they endure under the difpenfations of Providence, or by voluntary penances to which they fubmit, for the temporal penalties of fin, to which they are fubject, even after the remiffion of their eternal punifhment. Seff. 6. can. 30. and feff. 14. can. 8. and 9. In this connection we may mention the popifh diftinction of venial and mortal fins: the greateft evils arifing from the former are the temporary pains of purgatory; but no man, it is faid, can obtain the pardon of the latter without confeffing to a prieft, and performing the penances which he impofes.

The council of Trent (feff. 14. can. 1.) has exprefsly decreed, that every one is accurfed, who fhall affirm that penance is not truly and properly a facrament, inftituted by Chrift in the univerfal church, for reconciling thofe Chriftians to the divine majefty, who have fallen into fin after baptifm: and this facrament, it is declared, confifts of two parts, the matter and the form; the matter is the act of the penitent, including contrition, confeffion, and fatisfaction; the form of it is the act of abfolution on the part of the prieft. Accordingly it is enjoined, that it is the duty of every man, who hath fallen after baptifm, to confefs his fins once a year, at leaft, to a prieft: that this confeffion is to be fecret; for public confeffion is neither commanded nor expedient: and that it muft be exact and particular, including every kind and act of fin, with all the circumftances attending it. When the penitent has fo done, the prieft pronounces an abfolution; which is not conditional or declarative only, but abfolute and judicial. This fecret, or auricular confeffion, was firft decreed and eftablifhed in the fourth council of Lateran, under Innocent III. in 1215, (cap. 21.) And the decree of this council was afterwards confirmed and enlarged in the council of Florence, and in that of Trent; which ordains, that confeffion was inftituted by Chrift, that by the law of God it is neceffary to falvation, and that it has been always practifed in the Chriftian church. As for the penances impofed on the penitent by way of fatisfaction, they have been commonly the repetition of certain forms of devotion, as pater-nofters, or ave-marias, the payment of ftipulated fums, pilgrimages, fafts, or various fpecies of corporal difcipline. But the moft formidable penance, in the eftimation of many who have belonged to the Romifh communion, has been the temporary pains of purgatory. But under all the penalties which are inflicted or threatened in the Romifh church, it has provided relief by its indulgences, and by its prayers or maffes for the dead, performed profeffedly for relieving and refcuing the fouls that are detained in purgatory.

Another article that has been long authoritatively enjoined and obferved in the church of Rome, is the celibacy of her clergy. This was firft enjoined at Rome by Gregory VII. about the year 1074, and eftablifhed in England by Anfelm archbifhop of Canterbury about the year 1175; though his predeceffor Lanfranc had impofed it upon the prebendaries and clergy that lived in towns. And though the council of Trent was repeatedly petitioned by feveral princes and ftates to abolifh this reftraint, the obligation of celibacy was rather eftablifhed than relaxed by this council; for they decreed, that marriage contracted after a vow of continence, is neither lawful nor valid; and thus deprived the church of the poffibility of ever reftoring marriage to the clergy. For if marriage, after a vow, be in itfelf unlawful, the greateft authority upon earth cannot difpenfe with it, nor permit marriage to the clegry, who have already vowed continence.

To the doctrines and practices above recited may be farther added the worfhip of images, of which Proteftants accufe the Papifts. But to this accufation the Papift replies, that he keeps images by him to preferve

2 in

Popery. Papist Misrepresented and Represented.

in his mind the memory of the persons represented by them; as people are wont to preserve the memory of their deceased friends by keeping their pictures. He is taught (he says) to use them so as to cast his eyes upon the pictures or images, and thence to raise his heart to the things represented, and there to employ it in meditation, love, and thanksgiving, desire of imitation, &c. as the object requires.

These pictures or images have this advantage, that they inform the mind by one glance of what in reading might require a whole chapter. There being no other difference between them, than that reading represents leisurely and by degrees; and a picture, all at once. Hence he finds a convenience in saying his prayers with some devout pictures before him, he being no sooner distracted, but the sight of these recals his wandering thoughts to the right object; and as certainly brings something good into his mind, as an immodest picture disturbs his heart with filthy thoughts. And because he is sensible that these holy pictures and images represent and bring to his mind such objects as in his heart he loves, honours, and venerates; he cannot but upon that account love, honour, and respect, the images themselves.

The council of Trent likewise decreed, that all bishops and pastors who have the cure of souls, do diligently instruct their flocks, *that it is good and profitable to desire the intercession of saints reigning with Christ in heaven.* And this decree the Papists endeavour to defend by the following observations. They confess that we have but one Mediator of redemption; but affirm that it is acceptable to God that we should have many mediators of intercession. Moses (say they) was such a mediator for the Israelites; Job for his three friends; Stephen for his persecutors. The Romans were thus desired by St Paul to be his mediators; so were the Corinthians, so the Ephesians, *Ep. ad* Rom. Cor. Eph. so almost every sick man desires the congregation to be his mediators, by remembering him in their prayers. And so the Papist desires the blessed in heaven to be his mediators; that is, that they would pray to God for him. But between these living and dead mediators there is no similarity: the living mediator is present, and certainly hears the request of those who desire him to intercede for them; the dead mediator is as certainly absent, and cannot possibly hear the requests of all those who at the same instant may be begging him to intercede for them, unless he be possessed of the divine attribute of omnipresence; and he who gives that attribute to any creature is unquestionably guilty of idolatry. And as this decree is contrary to one of the first principles of natural religion, so does it receive no countenance from Scripture, or any Christian writer of the three first centuries. Other practices peculiar to the Papists are the religious honour and respect that they pay to sacred relicks; by which they understand not only the bodies and parts of the bodies of the saints, but any of those things that appertained to them, and which they touched; and the celebration of divine service in an unknown tongue: to which purpose the council of Trent hath denounced an anathema on any one who shall say that mass ought to be celebrated only in the vulgar tongue; sess. 25. and sess. 22. can. 9. Though the council of Lateran under Innocent III. in 1215 (can. 9.) had expressly decreed, that because in many

Ibid.

parts within the same city and diocese there are many people of different manners and rites mixed together, but of one faith, the bishops of such cities or dioceses should provide fit men for celebrating divine offices, according to the diversity of tongues and rites, and for administering the sacraments.

Popery, Popham.

We shall only add, that the church of Rome maintains, that unwritten traditions ought to be added to the holy Scriptures, in order to supply their defect, and to be regarded as of equal authority; that the books of the Apocrypha are canonical scripture; that the vulgate edition of the Bible is to be deemed authentic; and that the Scriptures are to be received and interpreted according to that sense which the holy mother church, to whom it belongs to judge of the true sense, hath held, and doth hold, and according to the unanimous consent of the fathers.

Such are the principal and distinguishing doctrines of Popery, most of which have received the sanction of the council of Trent, and that of the creed of pope Pius IV. which is received, professed, and sworn to by every one who enters into holy orders in the church of Rome; and at the close of this creed, we are told that the faith contained in it is so absolutely and indispensably necessary, that no man can be saved without it.

Many of the doctrines of Popery were relaxed, and very favourably interpreted by M. de Meaux, bishop of Condom, in his Exposition of the Doctrine of the Catholic Church, first printed in the year 1671: but this edition, which was charged with perverting, in endeavouring to palliate, the doctrine of the church, was censured by the doctors of the Sorbonne, and actually suppressed; nor does it appear that they ever testified their approbation in the usual form of subsequent and altered editions. It has, however, been lately published in this country, by a clergyman of the Romish church, whose integrity, piety, and benevolence, would do honour to any communion.

POPHAM (Sir John), lord chief justice of the common pleas in the reign of Queen Elizabeth, was the eldest son of Edward Popham, Esq; of Huntworth in Somersetshire, and born in the year 1531. He was some time a student of Baliol college in Oxford; "being then (says Ant. Wood) given at leisure hours to many sports and exercises." After quitting the university, he fixed in the Middle Temple; where, during his novitiate, he is said to have indulged in that kind of dissipation to which youth and a vigorous constitution more naturally incline than to the study of voluminous *reports*: but, satiated at length with what are called the *pleasures of the town*, he applied sedulously to the study of his profession, was called to the bar, and in 1568 became summer or autumn reader. He was soon after made serjeant at law, and solicitor-general in 1579. In 1581, he was appointed attorney-general, and treasurer of the Middle Temple. In 1592, he was made lord chief justice of the king's bench, and the same year received the honour of knighthood. In the year 1601, his lordship was one of the council detained by the unfortunate earl of Essex, when he formed the ridiculous project of defending himself in his house: and, on the earl's trial, he gave evidence against him relative to their detention. He died in the year 1607, aged 76; and was buried in

in the fouth aifle of the church at Wellington in Somerfetfhire, where he generally refided as often as it was in his power to retire. He was thought fomewhat fevere in the execution of the law againft capital offenders: but his feverity had the happy effect of reducing the number of highway robbers. He wrote, 1. Reports and cafes adjudged in the time of Queen Elizabeth. 2. Refolutions and judgments upon cafes and matters agitated in all the courts at Weftminfter in the latter end of Queen Elizabeth's reign.

POPLAR, in botany. See POPULUS.

POPLITÆUS, in anatomy, a fmall mufcle obliquely pyramidal, fituated under the ham. See ANATOMY, *Table of the Mufcles*.

POPPY, in botany. See OPIUM and PAPAVER.

POPULAR, fomething that relates to the common people.

POPULATION, means the ftate of a country with refpect to the number of people. See *Bills of MORTALITY* and *POLITICAL-Arithmetic*.

The queftion concerning the number of men exifting upon earth, has been varioufly determined by different writers. Riccioli ftates the population of the globe at 1000 millions, Voffius at 500; the Journalifts of Trevoux at 720; and the editor (Xavier de Feller) of the fmall Geographical Dictionary of Vofgien, reprinted at Paris in 1778, at 370 millions. This laft eftimate is perhaps too low, although the writer profeffes to have taken confiderable pains to afcertain the point with as much accuracy as the nature of the fubject will admit. It may, perhaps, not be deemed unworthy the attention of the curious fpeculatift to obferve, that affuming the more probable ftatement of the learned Jefuits of Trevoux, and that the world has exifted about 6006 years in its prefent ftate of population, then the whole number of perfons who have ever exifted upon earth fince the days of Adam amounts only to about one hundred and thirty thoufand millions; becaufe $720,000,000 \times 182$ (the number of generations in 6006 years) $= 131,040,000,000$. See on this fubject the authors above mentioned, as likewife Beaufobre's *Etude de la Politiqne*.

With regard to the population of England, the reader may confult, together with our article *POLITICAL-Arithmetic*, An Inquiry into the prefent State of Population, &c. by W. Wales, F. R. S. and Mr Howlett's Examination of Dr Price's Effay, on the fame fubject.

POPULUS, the POPLAR: A genus of the octandria order, belonging to the diœcia clafs of plants; and in the natural method ranking under the 50th order, *Amentaceæ*. The calyx of the amentum is a lacerated, oblong, and fquamous leaf; the corolla is turbinated, oblique, and entire. The female has the calyx of the amentum and corolla the fame as in the male; the ftigma is quadrifid; the capfule bilocular, with many pappous feeds.

The poplar, one of the moft beautiful of the aquatic trees, has frequently been introduced into the poetical defcriptions of the ancients; as by Virgil, *Ecl.* vii. 66. ix. 41. *Georg.* ii. 66. iv. 511. *Æn.* viii. 31. 276. by Ovid, *Amom. Parid.* 27. by Horace, *Carm.* ii. 3. and by Catulus, *Nupt. Pil. et Thet.* 290, &c. &c.

Species. 1. The alba, or abele-tree, grows naturally in the temperate parts of Europe. Its leaves are large, and divided into three, four, or five lobes, indented on their edges, of a very dark colour on their upper fide, but very white and downy on the under fide; ftanding upon footftalks an inch long. The young branches have a purple bark, and are covered with a white down; but the bark of the ftem and older branches is grey. In the beginning of April, the male flowers or catkins appear, which are cylindrical, and about three inches long. About a week after come out the female flowers or catkins, which have no ftamina like thofe of the male. Soon after thefe come out, the male catkins fall off; and in five or fix weeks after the female flowers will have ripe feeds inclofed in a hairy covering. The catkins will then drop, and the feeds be wafted by the winds to a great diftance. 2. The major, or white poplar, has its leaves rounder than the firft, and not much above half their fize: they are indented on their edges, and are downy on their under fide, but not fo white as thofe of the former, nor are their upper furfaces of fuch a deep green colour. 3. The nigra, or black poplar, has oval heart-fhaped leaves, flightly crenated on their edges; they are fmooth on both fides, and of a light green colour. 4. The tremula, or afpen-tree, has roundifh, angularly indented leaves: they are fmooth on both fides, and ftand on long footftalks, and fo are fhaken by the leaft wind; from whence it has the title of the *trembling poplar*, or *afpen-tree*. 5. The balfamifera, or Carolina poplar, is a native of Carolina, where it becomes a large tree. The fhoots of this fort grow very ftrong in Britain, and are generally angular; with a light green bark like the willow. The leaves on young trees, and alfo thofe on the lower fhoots, are very large, almoft heart-fhaped, and crenated; but thofe upon the older trees are fmaller: as the trees advance, their bark becomes lighter, approaching to a greyifh colour. 6. The tacamahaca, grows naturally in Canada and other parts of North America. This is a tree of a middling growth, fending out on every fide many fhort thick fhoots, which are covered with a light brown bark, garnifhed with leaves differing from one another in fhape and fize; moft of them are almoft heart-fhaped; but fome are oval, and others nearly fpear-fhaped; they are whitifh on their under fide, but green on their upper.

Culture. Thefe trees may be propagated either by layers or cuttings, as alfo from fuckers which the white poplars fend up from their roots in great plenty. The beft time for tranfplanting thefe fuckers is in October, when their leaves begin to decay. Thefe may be placed in a nurfery for two or three years, to get ftrength before they are planted out where they are defigned to remain; but if they are propagated from cuttings, it is better to defer the doing of that until February, at which time truncheons of two or three feet long fhould be thruft about a foot and a half into the ground.—Thefe will readily take root; and if the foil in which they are planted be moift, they will arrive at a confiderable bulk in a few years. The black poplar is lefs apt to take root from large truncheons; therefore it is a better method to plant cuttings of it about a foot and a half in length, thrufting them a foot deep in the ground. This fort will grow almoft on any foil, but will thrive beft in moift places. The Carolina poplar may alfo be propagated by cuttings or layers; but the laft is the method generally practifed, and the plants raifed

raiſed by it are leſs moiſt than others. The ſhoots of this tree, while young, are frequently killed down to a conſiderable length by the froſt in winter; but as the trees grow older, their ſhoots are not ſo vigorous, and become more ligneous, ſo are not liable to the ſame diſaſter. But the trees ſhould be planted in a ſheltered ſituation: for as their leaves are very large, the wind has great power over them; and the branches being tender, they are frequently broken or ſplit by the winds in ſummer, when they are much expoſed. The tacamahaca ſends up a great number of ſuckers from its roots, by which it multiplies in plenty; and every cutting which is planted will take root.

Uſes. The wood of theſe trees, eſpecially of the abele, is good for laying floors, where it will laſt for many years; and on account of its extreme whiteneſs is by many preferred to oak; yet, on account of its ſoft contexture, being very ſubject to take the impreſſion of nails, &c. it is leſs proper on this account than the harder woods. The abele likewiſe deſerves particular notice, on account of the virtue of its bark in curing intermitting fevers. The Reverend Mr Stone, in Phil. Tranſ. vol. LIII. p. 195. tells us, that he gathers the bark in ſummer when it is full of ſap, and having dried it by a gentle heat, gives a dram powdered every four hours betwixt the fits. In a few obſtinate caſes, he mixed one-fifth part of Peruvian bark with it. It is remarkable how nature has adapted remedies to diſeaſes. Intermitting fevers are moſt prevalent in wet countries; and this tree grows naturally in ſuch ſituations. The bark of it is an object well worthy the attention of phyſicians; and if its ſucceſs upon a more enlarged ſcale of practice prove equal to Mr Stone's experiments, the world will be much indebted to him for communicating them. This bark will alſo tan leather.

The inner bark of the black poplar is uſed by the inhabitants of Kamſchatka as a material for bread; and paper has ſometimes been made of the cottony down of the ſeeds. The roots have been obſerved to diſſolve into a kind of gelatinous ſubſtance, and to be coated over with a tubular cruſtaceous ſpar, called by naturaliſts *oſteocolla**, formerly imagined to have ſome virtue in producing the callus of a fractured bone. The buds of the ſixth ſpecies are covered with a glutinous reſin, which ſmells very ſtrong, and is the gum tacamahaca of the ſhops. The beſt, called, from its being collected in a kind of gourd-ſhells, *tacamahaca in ſhells*, is ſomewhat unctuous and ſoftiſh, of a pale yellowiſh or greeniſh colour, an aromatic taſte, and a fragrant delightful ſmell, approaching to that of lavender or ambergriſe. This ſort is very rare; that commonly found in the ſhops is in ſemitranſparent globes or grains, of a whitiſh, yellowiſh, browniſh, or greeniſh colour, of a leſs grateful ſmell than the foregoing. This reſin is ſaid to be employed externally by the Indians for diſcuſſing and maturating tumours, and abating pains in the limbs. It is an ingredient in ſome anodyne, hyſteric, cephalic, and ſtomachic plaſters; but the fragrance of the finer ſort ſufficiently points out its utility in other reſpects.

*ee Oſteo-colla

M. Fougeroux de Bondaroy, from a ſet of experiments on the ſubject, gives an account of the uſes of the ſeveral kinds of poplar, the ſubſtance of which is as follows: He finds that the wood of the black poplar is good and uſeful for many purpoſes; that the Lombardy poplar, *populus faſtigata*, is of very little value; that the Virginia poplar, *populus Virginiana*, affords a wood of excellent quality, that may be applied to many uſes. The Carolina poplar, *populus Carolinenſis—heterophilla*, (Linn.) is a very quick grower; beautiful when found, but liable to be hurt by cold. Its wood appeared to M. de Bondaroy to be of little value; but M. Maleſherbes, who cut down a large tree of this ſort, was aſſured by his carpenter that the wood was very good.—That the tacamahaca, *populus tacamahaca balſamifera*, is a dwarfiſh plant (A), of little value.—That the liard, *populus Canadenſis*, is a large tree, the wood light, not eaſy to be ſplit, and fit for ſeveral uſes.—That the white poplar, *populus alba*, is a large growing tree, affording a wood of excellent quality, and is among the moſt valuable of this ſpecies.—That the trembling poplar, *populus tremula*, (Linn.) is neither ſo large a tree nor affords ſuch wood as the former. Theſe are in few words the principal reſult of the experiments of this gentleman on this claſs of plants. A few other ſorts are mentioned, but nothing deciſive with regard to them is determined.

From ſome experiments made by M. Dambourney, it appears that the poplar may be uſefully employed in dyeing. The Italian poplar gives a dye of as fine a luſtre, and equally durable, as that of the fineſt yellow wood, and its colour is more eaſily extracted. It is likewiſe very apt to unite with other colours in compoſition. Beſide the *populus faſtigata*, M. Dambourney tried alſo the black poplar, the Virginian *ditto*, the balſam *ditto* or *liard*, the white *ditto*, and the trembling poplar; and found that all theſe dyed wool of a nut-colour, fawn-colour (*vigogne*), Nankin, muſk, and other grave ſhades, according to the quantity of wood employed, and the length of time it was boiled.

POQUELIN or Pocquelin (John Baptiſt.) See Moliere.

PORANA, in botany; a genus of the monogynia order, belonging to the pentandria claſs of plants. The corolla is campanulated; the calyx is quinquefid, and larger than the fruit; the ſtyle ſemibifid, long, and permanent; the ſtigmata globular; the perianthium bivalved.

PORCELAIN, a fine kind of earthen ware, chiefly manufactured in China, and thence called *China-ware.* All earthen wares which are white and ſemitranſparent are generally called *porcelains:* but amongſt theſe, ſo great differences may be obſerved, that, notwithſtanding the ſimilarity of their external appearance, they cannot be conſidered as matters of the ſame kind. Theſe differences are ſo evident, that even perſons who are not connoiſſeurs in this way prefer much the porcelain of ſome countries to that of others.

1 What is called porcelain.

The word *porcelain* is of European derivation; none of the ſyllables which compoſe it can even be pronounced or written by the Chineſe, whoſe language comprehends

2 Origin of the name.

(A) We have ſeen it above 30 feet high.

Porcelain. prehends no such sounds. It is probable that we are indebted to the Portuguese for it: the word *porcellana*, however, in their language, signifies properly a cup or dish; and they themselves distinguish all works of porcelain by the general name of *loca*. Porcelain is called in China *tsé-ki*.

3 Art of making it in greater perfection in the East than in Europe.

The art of making porcelain is one of those in which Europe has been excelled by oriental nations. The first porcelain that was seen in Europe was brought from Japan and China. The whiteness, transparency, fineness, neatness, elegance, and even the magnificence of this pottery, which soon became the ornament of sumptuous tables, did not fail to excite the admiration and industry of Europeans; and their attempts have succeeded so well, that in different parts of Europe earthen wares have been made so like the oriental, that they have acquired the name of *porcelain*. The first European porcelains were made in Saxony and in France; and afterwards in England, Germany, and Italy: but as all these were different from the Japanese, so each of them had its peculiar character.

4 Best Chinese porcelain at King-te-tching.

The finest and best porcelain of China is made in a village called *King-te-tching*, in the province of Kiang-si. This celebrated village is a league and a half in length, and we are assured that it contains a million of inhabitants. The workmen of King-te-tching, invited by the attracting allurements of the European trade, have established manufactories also in the provinces of Fo-kien and Canton; but this porcelain is not esteemed.— The emperor Kang-hi was desirous of having some made under his own inspection at Pe-king. For this purpose he collected workmen, together with tools, and all materials necessary; furnaces were also erected, but the attempt miscarried. The village of *King-te-tching* still continues the most celebrated place in the empire for beautiful porcelain, which is transported to all parts of the world, and even to Japan.

5 Origin of the art.

We are unable to discover who first found out the art of making porcelain, nor is it known whether the Chinese were indebted to chance for it, or to the repeated efforts of inventive genius; we cannot even determine its antiquity with precision; we know only from the annals of Feou-leang, a city in the district to which King-te-tching belongs, that, since the year 442 of our era, the workmen of this village have always furnished the emperors with porcelain; and that one or two mandarins were sent from court to inspect their labours. It is, however, supposed that the invention of porcelain is much older than that epocha.

6 F. d'Entrecolles first gave an account of Chinese porcelain.

We are indebted to Father d'Entrecolles, a Romish missionary, for a very accurate account of the manner in which porcelain is made in China; and as he lived in King-te-tching, his information must have been the very best possible. We shall therefore give his account of the Chinese manner of making it, as abridged by Grosier in his *General Description of China*.

7 Nature of the materials, and mode of preparing the paste.

The principal ingredients of the fine porcelain are *pe-tun-tse* and *kao-lin*, two kinds of earth from the mixture of which the paste is produced. The *kao-lin* is intermixed with small shining particles; the other is purely white, and very fine to the touch. These first materials are carried to the manufactories in the shape of bricks. The pe-tun-tse, which is so fine, is nothing else but fragments of rock taken from certain quarries, and reduced to powder. Every kind of stone is not fit for this purpose. The colour of that which is good, say the Chinese, ought to incline a little towards green. A large iron club is used for breaking these pieces of rock: they are afterwards put into mortars; and, by means of levers headed with stone bound round with iron, they are reduced to a very fine powder. These levers are put in action either by the labour of men, or by water, in the same manner as the hammers of our paper-mills. The dust afterwards collected is thrown into a large vessel full of water, which is strongly stirred with an iron shovel. When it has been left to settle for some time, a kind of cream rises on the top, about four inches in thickness, which is skimmed off, and poured into another vessel filled with water: the water in the first vessel is stirred several times; and the cream which arises is still collected, until nothing remains but the coarse dregs, which, by their own weight, precipitate to the bottom: these dregs are carefully collected, and pounded anew.

With regard to what is taken from the first vessel, it is suffered to remain in the second until it is formed into a kind of crust at the bottom. When the water above it seems quite clear, it is poured off by gently inclining the vessel, that the sediment may not be disturbed; and the paste is thrown into large moulds proper for drying it. Before it is entirely hard, it is divided into small square cakes, which are sold by the hundred. The colour of this paste, and its form, have occasioned it to receive the name of *pe tun-tse*.

The kao-lin, which is used in the composition of porcelain, requires less labour than the pe-tun-tse. Nature has a greater share in the preparation of it. There are large mines of it in the bosoms of certain mountains, the exterior strata of which consist of a kind of red earth. These mines are very deep, and the kao-lin is found in small lumps, that are formed into bricks after having gone through the same process as the pe-tun-tse. Father d'Entrecolles thinks, that the earth called *terre de Malte*, or St Paul's earth, has much affinity to the kao-lin, although those small shining particles are not observed in it which are interspersed in the latter.

It is from the kao-lin that fine porcelain derives all its strength; if we may be allowed the expression, it stands it instead of nerves. It is very extraordinary, that a soft earth should give strength and consistency to the pe-tun-tse, which is procured from the hardest rocks. A rich Chinese merchant told F. d'Entrecolles, that the English and Dutch had purchased some of the pe-tun-tse, which they transported to Europe with a design of making porcelain; but having carried with them none of the kao-lin, their attempt proved abortive, as they have since acknowledged. "They wanted (said this Chinese, laughing) to form a body, the flesh of which should support itself without bones."

8 A new substance discovered and used by the Chinese.

The Chinese have discovered, within these few years, a new substance proper to be employed in the composition of porcelain. It is a stone, or rather species of chalk, called *hoa-che*, from which the physicians prepare a kind of draught that is said to be detersive, aperient, and cooling. The manufacturers of porcelain have thought proper to employ this stone instead of kao-lin. It is called hoa, because it is glutinous, and has a great resemblance to soap. Porcelain made with hoa-che is very rare, and much dearer than any other. It has an exceeding fine grain, and, with regard to the painting, if it be compared with that of the common porcelain, it

it appears to ſurpaſs it as much as vellum does paper. This porcelain is, beſides, ſo light, that it ſurpriſes thoſe who are accuſtomed to handle other kinds; it is alſo much more brittle; and it is very difficult to hit upon the proper degree of tempering it.

Hoa-che is ſeldom uſed in forming the body of the work; the artiſt is contented ſometimes with making it into a very fine ſize, in which the veſſel is plunged when dry, in order that it may receive a coat before it is painted and varniſhed: by theſe means it acquires a ſuperior degree of beauty.

When hoa-che is taken from the mine, it is waſhed in rain or river water, to ſeparate it from a kind of yellow earth which adheres to it. It is then pounded, put into a tub filled with water to diſſolve it, and afterwards formed into cakes like kao-lin. We are aſſured that hoa-che, when prepared in this manner, without the mixture of any other earth, is alone ſufficient to make porcelain. It ſerves inſtead of kao-lin; but it is much dearer. Kao-lin coſts only ten-pence Sterling; the price of hoa-che is half-a-crown: this difference, therefore, greatly enhances the value of porcelain made with the latter.

9
The ſplendor and whiteneſs of their porcelain derived from oil or varniſh.

To pe-tun-tſe and kao-lin, the two principal elements, muſt be added the oil or varniſh from which it derives its ſplendor and whiteneſs. This oil is of a whitiſh colour, and is extracted from the ſame kind of ſtone which produces the pe-tun-tſe, but the whiteſt is always choſen, and that which has the greeneſt ſpots. The oil is obtained from it by the ſame proceſs uſed in making the pe-tun-tſe: the ſtone is firſt waſhed and pulverized; it is then thrown into water, and after it has been purified it throws up a kind of cream. To 100 pounds of this cream is added one pound of che-kao, a mineral ſomething like alum, which is put into the fire till it becomes red-hot and then pounded. This mineral is a kind of runnet, and gives a conſiſtence to the oil, which is however carefully preſerved in its ſtate of fluidity. The oil thus prepared is never employed alone, another oil muſt be mixed with it, which is extracted from lime and fern aſhes, to 100 pounds of which is alſo added a pound of che-kao. When theſe two oils are mixed, they muſt be equally thick; and in order to aſcertain this, the workmen dip into each of them ſome cakes of the pe-tun-tſe, and by inſpecting their ſurfaces cloſely after they are drawn out, thence judge of the thickneſs of the liquors. With regard to the quantity neceſſary to be employed, it is uſual to mix 10 meaſures of ſtone-oil with one meaſure of the oil made from lime and fern aſhes.

10
Their mode of mixing the ſubſtances,

The firſt labour conſiſts in again purifying the pe-tun-tſe and the kao-lin. The workmen then proceed to mix theſe two ſubſtances together. For fine porcelain they put an equal quantity of the kao-lin and the pe-tun-tſe; for the middling ſort they uſe four parts of the kao-lin and ſix of the pe-tun-tſe. The leaſt quantity put of the former is one part to three of the pe-tun-tſe. When this mixture is finiſhed, the maſs is thrown into a large pit, well paved and cemented in every part; it is then trod upon, and kneaded until it becomes hard. This labour is ſo much the more fatiguing, as it muſt be continued without intermiſſion: were it interrupted, all the other labourers would remain unemployed. From this maſs, thus prepared, the workmen detach different pieces, which they ſpread out upon large ſlates, where they knead and roll them in every direction, carefully obſerving to leave no vacuum in them, and to keep them free from the mixture of any extraneous body. A hair or a grain of ſand would ſpoil the whole work. When this paſte has not been properly prepared, the porcelain cracks, and melts or becomes warped.

11
And of faſhioning the works.

All plain works are faſhioned with the wheel. When a cup has undergone this operation, the outſide of its bottom is quite round. The workman firſt gives it the requiſite height and diameter, and it comes from his hands almoſt the moment he has received it. He is under the neceſſity of uſing expedition, as he is paid not quite a farthing per board, and each board contains 26 pieces. This cup paſſes then to a ſecond workman, who forms its baſe. A little after it is delivered to a third, who applies it to his mould, and gives it a proper form; when he takes it off the mould, he muſt turn it very ſoftly, and be careful not to preſs it more on one ſide than on another; without this precaution it would become warped or disfigured. A fourth workman poliſhes it with a chiſſel, eſpecially around the edges, and diminiſhes its thickneſs, in order to give it a certain degree of tranſparency. At length, after having paſſed through all the hands neceſſary for giving it all its ornaments, it is received, when dry, by the laſt workman, who faſhions its bottom with a chiſſel. It is aſtoniſhing to ſee with what dexterity and expedition the workmen convey theſe vaſes from one to another. We are aſſured, that a piece of porcelain, before it is finiſhed, muſt paſs through the hands of 70 perſons.

12
Large works executed in parts and cemented.

Large works are executed in parts which are faſhioned ſeparately. When all the pieces are finiſhed, and almoſt dry, they are put together and cemented with paſte made of the ſame ſubſtance, and ſoftened with water. Some time after, the ſeams are poliſhed with a knife, both without and within; and when the veſſel is covered with varniſh, it entirely conceals them, ſo that the leaſt trace of them is not to be ſeen. It is in this manner that ſpouts, handles, rings, and other parts of the ſame nature, are added. This is the caſe, particularly in thoſe pieces which are faſhioned upon moulds or modelled with the hands, ſuch as emboſſed works, groteſque images, idols, figures of trees or animals, and buſts, which the Europeans order. All theſe are formed of four or five pieces joined together, which are afterwards brought to perfection with inſtruments proper for carving, poliſhing, and finiſhing, the different traces which the mould has left imperfect. With regard to thoſe flowers and ornaments which are not in relief, they are either engraven or imprinted with a ſtamp. Ornaments in relief, prepared ſeparately, are alſo added to pieces of porcelain, almoſt in the ſame manner as lace is put upon a coat.

13
Their manner of painting porcelain;

After a piece of porcelain has been properly faſhioned, it then paſſes into the hands of the painters. Theſe hoa-pei, or painters in porcelain, are equally indigent as the other workmen; they follow no certain plan in their art, nor are they acquainted with any of the rules of drawing; all their knowledge is the effect of practice, aſſiſted by a whimſical imagination. Some of them, however, ſhow no inconſiderable ſhare of taſte in painting flowers, animals, and landſcapes, on porcelain, as well as upon the paper of fans, and the ſilk uſed for filling up the ſquares of lanterns. The labour of painting, in

Porcelain. in the manufactories of which we have spoken, is divided among a great number of hands. The business of one is entirely confined to tracing out the first coloured circle, which ornaments the brims of the vessel; another designs the flowers, and a third paints them; one delineates waters and mountains, and another birds and other animals: human figures are generally the worst executed.

14
And of making it appear covered with veins.

The tsou-you, which is a kind of oil procured from white flint, has the peculiar property of making those pieces of porcelain upon which it is laid appear to be covered with an infinitude of veins in every direction; at a distance one would take them for cracked vases, the fragments of which have not been displaced. The colour communicated by this oil is a white, somewhat inclining to that of ashes. If it be laid upon porcelain, entirely of an azure blue, it will appear in the same manner to be variegated with beautiful veins. This kind of porcelain is called *tsoui-ki*.

15
A singular secret which they have now lost.

The Chinese make vases also ornamented with a kind of fret-work, perforated in such a manner as to resemble very fine lace. In the middle is placed a cup proper for holding any liquid; and this cup makes only one body with the former, which appears like lace wrapped round it. The Chinese workmen had formerly the secret of making a still more singular kind of porcelain: they painted upon the sides of the vessel fishes, insects, and other animals, which could not be perceived until it was filled with water. This secret is in a great measure lost: the following part of the process is, however, preserved. The porcelain, which the workman intends to paint in this manner, must be extremely thin and delicate. When it is dry, the colour is laid on pretty thick, not on the outside, as is generally done, but on the inside. The figures painted upon it, for the most part, are fishes, as being more analogous to the water with which the vessel is filled. When the colour is thoroughly dry, it is coated over with a kind of size, made from porcelain-earth; so that the azure is entirely inclosed between two laminæ of earth. When the size becomes dry, the workman pours some oil into the vessel, and afterwards puts it upon a mould and applies it to the lath. As this piece of porcelain has received its consistence and body within, it is made as thin on the outside as possible, without penetrating to the colour; its exterior surface is then dipped in oil, and when dry it is baked in a common furnace. The art of making these vases requires the most delicate care, and a dexterity which the Chinese perhaps do not at present possess. They have, however, from time to time made several attempts to revive the secret of this magic painting, but their success has been very imperfect. This kind of porcelain is known by the name of *kia-tsing*, "pressed azure."

16
Their mode of baking porcelain.

After the porcelain has received its proper form, its colours, and all the intended ornaments, it is transported from the manufactory to the furnace, which is situated sometimes at the other end of King-te-tching. In a kind of portico, which is erected before it, may be seen heaps of boxes and cases made of earth, for the purpose of inclosing the porcelain. Each piece, however inconsiderable it may be, has its case; and the Chinese workman, by this procedure, imitates nature, which, in order to bring the fruits of the earth to proper maturity, clothes them in a covering, to defend them from the excessive heat of the sun during the day, and from the severity of the cold during the night.

Porcelain.

In the bottom of these boxes is put a layer of fine sand, which is covered over with powder of the kao-lin, to prevent the sand from adhering too closely to the bottom of the vessel. The piece of porcelain is then placed upon this bed of sand, and pressed gently down, in order that the sand may take the form of the bottom of the vessel, which does not touch the sides of its case: the case has no cover. A second, prepared in the same manner, and containing its vessel, is fitted into the first, so that it entirely shuts it, without touching the porcelain which is below; and thus the furnace is filled with piles of cases, which defend the pieces they contain from the too direct action of the fire.

With regard to small pieces of porcelain, such as tea-cups, they are inclosed in common cases about four inches in height. Each piece is placed upon a saucer of earth about twice as thick as a crown-piece, and equal in breadth to its bottom. These small bases are also sprinkled over with the dust of the kao-lin. When the cases are large, the porcelain is not placed in the middle, because it would be too far removed from the sides, and consequently from the action of the fire.

These piles of cases are put into the furnace, and placed upon a bed of coarse sand, half a foot in thickness; those which occupy the middle space are at least seven feet high. The two boxes which are at the bottom of each pile remain empty, because the fire acts too feebly upon them, and because they are partly covered by the sand. For the same reason, the case placed at the top of each pile is also suffered to be empty. The piles which contain the finest porcelain are placed in the middle part of the furnace; the coarsest are put at its farther extremity; and those pieces which have the most body and the strongest colouring are near its mouth.

These different piles are placed very closely in the furnace; they support each other mutually by pieces of earth, which bind them at the top, bottom, and middle; but in such a manner that a free passage is left for the flame to insinuate itself everywhere around them.

17
Nature of their furnaces.

Before each of these furnaces for baking porcelain there is a long porch, which conveys air, and supplies in certain respects the place of a bellows. It serves for the same purposes as the arch of a glasshouse. "These furnaces (says Father d'Entrecolles), which were formerly only six feet in height and the same in length, are constructed now upon a much larger plan: at present they are two fathoms in height, and almost four in breadth; and the sides and roof are so thick, that one may lay the hand upon them without being incommoded by the heat. The dome or roof is shaped like a funnel, and has a large aperture at the top, through which clouds of flame and smoke incessantly issue. Besides this principal aperture, there are five others smaller, which are covered with broken pots, but in such a manner that the workman can increase or diminish the heat according as it may be found most convenient: through these also he is enabled to discover when the porcelain is sufficiently baked. Having uncovered that hole which is nearest the principal aperture, he takes a pair of pincers, and opens one of the cases: if he observes a bright fire in the furnace, if all the cases be red-

red-hot, and if the colours of the porcelain appear with full luſtre, he judges that it is in a proper ſtate; he then diſcontinues the fire, and entirely cloſes up the mouth of the furnace for ſome time. In the bottom of the furnace there is a deep hearth about two feet in breadth, over which a plank is laid, in order that the workman may enter to arrange the porcelain. When the fire is kindled on this hearth, the mouth of the furnace is immediately cloſed up, and an aperture is left only ſufficient for the admiſſion of faggots about a foot in length, but very narrow. The furnace is firſt heated for a day and night; after which two men keep continually throwing wood into it, and relieve each other by turns: 180 loads are generally conſumed for one baking. As the porcelain is burning hot, the workman employs for the purpoſe of taking it out long ſcarfs or pieces of cloth, which are ſuſpended from his neck."

18 heir different claſſes of porcelain.

The Chineſe divide their porcelain into ſeveral claſſes, according to its different degrees of fineneſs and beauty. The whole of the firſt is reſerved for the emperor. None of theſe works ever come into the hands of the public, unleſs they have blemiſhes or imperfections which render them unworthy of being preſented to the ſovereign. It is much to be doubted whether any of the largeſt and fineſt porcelain of China has ever been brought to Europe; the miſſionaries at leaſt aſſure us that none of that kind is ſold at Canton. The Chineſe ſet ſome value upon the Dreſden porcelain, and ſtill more upon that which comes from the manufactories of France.

19 rcelain ſt examined ſcienically by aumur

The illuſtrious Reaumur firſt attended to the manufacture of porcelain as a ſcience, and communicated his reſearches in two memoirs before the Academy of Sciences in 1727 and 1729. He did not ſatisfy himſelf with conſidering the external appearance, the painting and gilding, which are only ornaments not eſſential to the porcelain, but he endeavoured to examine it internally; and having broken pieces of the Japaneſe, Saxon, and French porcelains, he examined the difference of their grains (which name is given to their internal ſtructure). The grain of the Japaneſe porcelain appeared to him to be fine, cloſe, compact, moderately ſmooth, and ſomewhat ſhining. The grain of the Saxon porcelain was found to be ſtill more compact, not granulous, ſmooth, ſhining like enamel. Laſtly, the porcelain of St Cloud had a grain much leſs cloſe and fine than that of Japan; not, or but little, ſhining; and reſembling the grain of ſugar.

20 fferent ds of it.

From theſe firſt obſervations Mr Reaumur perceived that porcelains differed conſiderably. That he might examine them further, he expoſed them to a violent heat. More eſſential differences than thoſe of the grain appeared upon this trial; for the Japaneſe porcelain was unalterable by the fire, and all the European were melted.

21 true mpoſin diſcored by aumur,

This eſſential difference betwixt the Japaneſe and European porcelains ſuggeſted to Mr Reaumur a very ingenious thought, and in many reſpects true, concerning the nature of porcelain in general. As all porcelains ſomewhat reſemble glaſs in conſiſtence and tranſparency, though they are leſs compact and much leſs tranſparent, Mr Reaumur conſidered them as ſemivitrifications. But every ſubſtance may appear, and may actually be, in a ſemivitrified ſtate in two ways; for, firſt, it may be entirely compoſed of vitrifiable or fuſible matters; and in this caſe, by expoſing it to the action of fire, it will be actually melted or vitrified, if the heat be ſufficiently ſtrong and long continued. But as this change is not made inſtantly, eſpecially when the heat is not very violent; and as it paſſes through different ſtages or degrees, which may be more eaſily obſerved as the heat is better managed: hence, by ſtopping in proper time the application of heat to porcelain made in this manner, we may obtain it in an intermediate ſtate betwixt thoſe of crude earths and of completely vitrified ſubſtances, and alſo poſſeſſed of the ſemitranſparency and of the other ſenſible qualities of porcelain. We know alſo, that if ſuch porcelain be expoſed to a ſtronger degree of heat, it will then be completely fuſed and entirely vitrified. But the European porcelains tried by Mr Reaumur had this fuſibility; from which he concluded, that their compoſition is founded upon the above-mentioned principle.

In the ſecond place, a paſte of porcelain may be compoſed of fuſible and vitrifiable matter, mixed with a certain proportion of another matter which is abſolutely unfuſible in the fires of our furnaces. We may eaſily perceive, that if ſuch a mixture be expoſed to a heat ſufficient to melt entirely the vitrifiable ingredient, that this matter will actually melt: but as it is intermixed with another matter which does not melt, and which conſequently preſerves its conſiſtency and opacity, the whole muſt form a compound partly opaque and partly tranſparent, or rather a ſemitranſparent maſs; that is, a ſemivitrified ſubſtance or porcelain, but of a kind very different from the former; for as the fuſible part of this latter has produced all its effect, and as it has been as much fuſed as it can be during the baking of the porcelain, the compound may be expoſed a ſecond time to a more violent fire, without approaching nearer to a complete vitrification, or without departing from its ſtate of porcelain. But as oriental porcelain has preciſely theſe appearances and properties, Mr Reaumur concludes with reaſon, that it is compoſed upon this principle; and he afterwards confirmed his opinion by undeniable facts.

Mr Reaumur examined the pe-tun-tſe and kao-lin of the Chineſe, and having expoſed them ſeparately to a violent fire, he diſcovered that the pe-tun-tſe had fuſed without addition, and that the kao-lin had given no ſign of fuſibility. He afterwards mixed theſe matters, and formed cakes of them, which by baking were converted into porcelain ſimilar to that of China. Mr Reaumur eaſily found, that the pe-tun-tſe of the Chineſe was a hard ſtone of the kind called *vitrifiable*, but much more fuſible than any of thoſe which were known in Europe; and that the kao-lin was a talky matter, reduced to a very fine powder. From that time he hoped to make a porcelain of the ſame kind as the Chineſe with materials found in France. Whether he could not find any materials equal to thoſe of China, particularly that material analogous to the pe-tun-tſe of the Chineſe, or becauſe other occupations prevented the continuance of his reſearches, we do not know; but we find, from his ſecond memoir upon porcelain, that he afterwards attempted to make an artificial pe-tun-tſe, by mixing our vitrifiable ſtones with ſalts capable of rendering them fuſible, or even by ſubſtituting for it glaſs ready formed, and by adding to theſe ſuch ſub-

ſtances

Porcelain ſtances as he thought might be ſubſtituted for kao-lin. But he probably found he could not execute theſe intentions; for he did not reſume this ſubject from the year 1729 to 1739, when he gave a proceſs for converting common glaſs to a ſingular kind of porcelain, to which he had given his name, and of which an account is given under CHEMISTRY, n° 591—594. See alſo the article *Glass-Porcelain*.

22 Who converted glaſs into a kind of porcelain.

23 He is miſtaken in ſome particulars.

Although Mr Reaumur has ſurmounted many difficulties, and has given juſt notions concerning this ſubject, yet he has been miſtaken, or rather miſled, in two important points. His firſt error concerns the Saxon porcelain, which he confounds with the other fuſible porcelains made in Europe. Formerly, indeed, a porcelain might be made in Saxony, compoſed entirely of fuſible or vitrifiable materials, the vitrification of which was ſtopt in proper time, and which Mr Reaumur had examined. But now we are certainly informed, that all of that country is capable of reſiſting the moſt violent fires without fuſion, as well at leaſt as thoſe of China and Japan. Mr Reaumur might have been miſled by the appearance of the internal texture of this porcelain. For when a piece of it is broken, its internal ſurface does not appear granulous, but compact, uniform, ſmooth, ſhining, and much reſembling white enamel. But this appearance, ſo far from ſhowing that Saxon porcelain is a fuſed or vitrified ſubſtance, proves that it is not entirely compoſed of fuſible matters. All who have conſidered attentively this ſubject know, that the internal ſurface of the moſt fuſible porcelains is alſo the leaſt denſe and leaſt compact; the reaſon of which is, that no vitreous matter can be ſmooth and denſe internally, unleſs it has been completely fuſed. But if the denſity and ſhining appearance of the internal ſurface of the Saxon porcelain were only the effects of the fuſion of a vitreous matter, how could we conceive that veſſels formed of that matter ſhould have ſuſtained the neceſſary fuſion for giving this denſity and ſhining appearance, without having entirely loſt their ſhape? The impoſſibility of this is evident to any perſons who have been converſant in theſe matters and in the fuſion of glaſs.

24 Difference between Saxon and oriental porcelain

This quality of the Saxon porcelain muſt therefore proceed from another cauſe. It does indeed contain, as every porcelain does, particularly thoſe of China and Japan, a fuſible ſubſtance, which has been even completely fuſed during the baking. Its denſity alſo, and its internal luſtre, proceed chiefly from this fuſed matter: but we are alſo certain, that it contains a large quantity of a ſubſtance abſolutely unfuſible, from which it receives its admirable whiteneſs, its firmneſs and ſolidity, during the baking; in a word, which ſupplies the place of the oriental kao-lin, and which has the property of contracting its dimenſions conſiderably while it incorporates with the fuſible ſubſtance. If it be ſubjected to the moſt deciſive trial, namely, the action of a violent fire, capable of melting every porcelain compoſed of fuſible matters alone, "I affirm (ſays Mr Macquer), after many experiments, that it cannot be fuſed, unleſs by a fire capable alſo of melting the beſt Japaneſe porcelain." The Saxon porcelain is therefore not to be confounded with thoſe which are vitreous and fuſible; but is in its kind as excellent as that of Japan, and perhaps ſuperior, as we ſhall ſee when we enumerate the qualities which conſtitute the excellence of porcelain. The ſubject of Mr Reaumur's ſecond error, or at leaſt that which he has not ſufficiently explained, is the kao-lin of China. According to him, this matter is a fine talky powder, from the mixture of which with pe-tun-tſe the oriental porcelain is formed. Poſſibly a very finely ground talky ſubſtance mixed with pe-tun-tſe might form a porcelain ſimilar to the oriental; but perſons acquainted with the manufacture of any porcelain muſt perceive the impoſſibility of forming veſſels, unleſs the paſte of which they are made be ſo ductile and tenacious that it may be worked upon a potter's lathe, or at leaſt that it may be moulded. But talks, or any kinds of ſtones, however finely ground, cannot acquire the requiſite tenacity, which clays only, of all known earthy ſubſtances, poſſeſs. The Chineſe porcelain veſſels evidently appear to be turned upon the lathe, ſince they retain the marks of it: hence they muſt have been formed of a very tenacious paſte, and conſequently the kao-lin is not a purely talky matter, but is mixed with clay; or elſe the pe-tun-tſe and kao-lin are not, as Mr Reaumur ſuppoſes, the only ingredients of which Chineſe porcelain is formed, but a ſufficient quantity of ſome binding matter, unknown to Father d'Entrecolles and Mr Reaumur, muſt be alſo added.

Chem. Dict.

25 Manufactories of porcelain in different countries.

Although, ſince Mr Reaumur, no ſcientific perſon has written concerning porcelain, many have attempted to make it. Manufactories have been eſtabliſhed in almoſt all the ſtates of Europe. Beſides that of Saxony, which has been long eſtabliſhed, porcelain is alſo made at Vienna, at Frankendal, and lately in the neighbourhood of Berlin. All theſe German porcelains are ſimilar to the Saxon; and are made of materials of the ſame kind, although they differ ſomewhat from each other. England and Italy alſo have their porcelains, the chief of which are thoſe of Chelſea and of Naples. M. de la Condamine, in his laſt journey into Italy, viſited a manufacture of porcelain eſtabliſhed at Florence by the marquis de la Ginori, then governor of Leghorn. M. de la Condamine obſerved particularly the large ſize of ſome pieces of this porcelain. He ſays he ſaw ſtatues and groups half as large as nature, modelled from ſome of the fineſt antiques. The furnaces in which the porcelain was baked were conſtructed with much art, and lined with bricks made of the porcelain materials. The paſte of this porcelain is very beautiful; and from the grain of broken pieces, it appears to have all the qualities of the beſt Chineſe porcelain. A whiter glazing would be deſirable, which they might probably attain, if the Marquis Ginori was not determined to uſe thoſe materials only which were found in that country.

But in no ſtate of Europe have ſuch attempts been made to diſcover porcelain, or ſo many manufactories of it been eſtabliſhed, as in France. Before even Mr Reaumur had publiſhed on this ſubject, porcelain was made at St Cloud, and in the ſuburb of St Antoine at Paris, which was of the vitreous and fuſible kind, but conſiderably beautiful. Since that time, conſiderable manufactories of it have been eſtabliſhed at Chantilly, at Villeroi, and at Orleans; the porcelains of which have a diſtinguiſhed merit. But the porcelain produced in the king's manufacture at Sevres holds at preſent the firſt rank from its ſhining white, its beautiful glazing, and coloured grounds; in which no porcelain

has ever equalled it. The magnificence of the gilding, the regularity and elegance of its forms, ſurpaſs every thing of the kind.

26 Guettard's diſcoveries.

Mr Guettard has publiſhed an account of his diſcoveries on this ſubject, in the Memoirs of the Academy of Sciences for the year 1765. The kao-lin which he employed was a white argillaceous earth, filled with mica, which he found in the neighbourhood of Alençon; and his pe-tun-tſe is a hard, quartzoſe, grit ſtone, found abundantly in the ſame country, with which the ſtreets of Alençon are paved. We alſo know that Mr Guettard had begun to make his experiments on porcelain with theſe materials in the year 1751, together with the then Duke of Orleans, to whom he was attached. The Count de Lauraguais, of the Academy of Sciences, engaged in the purſuit of porcelain for ſeveral years with uncommon ardour and conſtancy. He ſpared no trouble nor expence to attain his purpoſe, which was to make porcelain equal in all reſpects to that of China and Japan. He ſhowed ſome pieces made by him in the year 1766 to the members of the Academy of Sciences. The perſons appointed by them to examine it gave their opinion, "that of all the porcelains made in the country, that of the Count de Lauraguais moſt reſembles the porcelain of China and Japan in ſolidity, grain, and unfuſibility." It were to be wiſhed that it poſſeſſed equally the other qualities eſſential to the excellence of porcelain, namely, the whiteneſs and luſtre obſervable in the ancient Japaneſe porcelain.

27 What perfection of porcelain conſiſts.

We ſhall now ſhow what thoſe qualities are which conſtitute the perfection of porcelain. We muſt firſt carefully diſtinguiſh the qualities which only contribute to the beauty and external appearance, from the intrinſic and eſſential properties in which the goodneſs and ſolidity of porcelain conſiſt. All perſons who have made experiments in this way have ſoon diſcovered the poſſibility of making compounds very white, beautifully ſemi-tranſparent, and covered with a ſhining glazing; but which cannot be worked for want of tenacity, are not ſufficiently compact, are eſſentially fuſible, are ſubject to break by ſudden application of heat and cold; and, laſtly, the glazing of which cracks, becomes rough, and conſequently loſes its luſtre by uſe, becauſe it is too ſoft.

On the other ſide, we ſhall alſo find it not difficult to compoſe very tenacious paſtes which ſhall be capable of being eaſily worked and well baked; which in the baking ſhall acquire the deſirable hardneſs and denſity; which are unfuſible, and capable of ſuſtaining very well the ſudden change of heat and cold; and, in a word, which ſhall have all the qualities of the moſt excellent porcelain excepting whiteneſs and beauty. We ſhall ſoon ſee that the materials fit for the compoſition of ſuch porcelains may be found abundantly in every country. The only difficulty, then, in this inquiry concerning porcelain, is to unite beauty and goodneſs in one compoſition; and indeed nature ſeems to be very ſparing of materials fit for this purpoſe, and therefore perfect porcelain will always be a dear and valuable commodity.

28 Stone-ware a kind of porcelain.

Thoſe potteries which we call *ſtone-ware* are not of modern invention, and have all the eſſential qualities of the beſt Japaneſe. For if we except whiteneſs, on which alone the ſemi-tranſparency depends, and compare all the properties of Japaneſe porcelain with thoſe of our ſtone-ware, no difference can be found betwixt them. The ſame grain appears internally in both; the ſame ſound is produced by ſtriking them when properly ſuſpended; the ſame denſity, the ſame hardneſs by which they ſtrike fire with ſteel, the ſame faculty of ſuſtaining the heat of boiling liquors without breaking, and the ſame unfuſibility in fire, are obſervable. Laſtly, if the earths of which ſtone-ware is made were free from heterogeneous colouring matters, which prevent their whiteneſs and ſemi-tranſparency; if veſſels were carefully formed; if all the proper attentions were given; and if theſe veſſels were covered over with a fine glazing—they would be as perfect porcelain as that of Japan. The moſt perfect porcelain, therefore, is nothing elſe than a fine white ſtone-ware.

Earths of this kind are probably more rare in Europe than in Japan and China. And probably alſo the want of theſe earths was the cauſe that the firſt makers of porcelain in this country confined themſelves to an external imitation, by employing nothing but vitrifiable matters with fuſible ſalts and a ſmall quantity of white earth, from which fuſible and vitreous porcelains were compoſed, which might be called *falſe porcelains*. But things are much changed ſince theſe firſt attempts. Beſides the diſcoveries of the Count de Lauraguais and of Mr Guettard, genuine white porcelains have been made a long time ago in Germany, eſpecially in Saxony and at Frankendal.

29 Genuine porcelain made in ſome countries of Europe.

Theſe porcelains are not inferior in any reſpect to the oriental; they are even much ſuperior in beauty and whiteneſs to the modern oriental porcelain, which has much degenerated in theſe reſpects; they ſeem even to excel the oriental in the moſt valuable quality of porcelain, namely, the property of ſuſtaining the ſudden change of heat and cold. We cannot judge of the quality of porcelain by a ſlight trial: for ſo many circumſtances concur to make a piece of porcelain capable or incapable of ſuſtaining the ſudden application of heat and of cold, that if at the ſame time boiling water be poured into two veſſels, one of which is good porcelain and the other bad, the former may poſſibly break and the latter remain entire. The only true method of diſcovering good porcelain in this reſpect is, to examine ſeveral pieces of it which are daily uſed; for inſtance, a ſet of coffee-cups. But it has been obſerved, that in many ſuch pieces of oriental porcelain, which have been long and daily uſed, cracks in the direction of their height may be always perceived, which are never ſeen in the good European porcelains.

30 Excellency of the ancient Japaneſe porcelain.

Every one talks of porcelain, and yet few are connoiſſeurs of it. None can be conſidered as ſuch but thoſe who have long made it an object of their inquiries. That the ancient Japaneſe porcelain is the moſt perfect is a general opinion. This porcelain is indeed very beautiful, and we muſt alſo acknowledge that its quality is excellent. It has been our model, and has long been the object of our admiration and emulation; but which we have been never able to equal, and which many perſons believe never can be equalled. Some perſons even decry the Saxon porcelain for a quality which really gives it a ſuperiority to the Japaneſe, namely, the greater ſmoothneſs, luſtre, and leſs granulous appearance of its internal ſurface than the oriental. The reſemblance of this ſurface to that of glaſs has evidently ſuggeſted this notion; and it would be well founded if the

denſity and luſtre of this porcelain proceeded only from a fuſible and vitreous quality; but as they do not, and as this porcelain is as fixed and as unfuſible as the Japaneſe, its denſity, ſo far from being a fault, is a valuable quality: for we muſt allow, that of porcelains equal in other reſpects, thoſe are beſt which are moſt firm and compact. Hence the interior ſubſtance of the Japaneſe porcelain is eſteemed for its greater denſity, compactneſs, and luſtre, than our vitreous ſand or fritt porcelains; becauſe theſe qualities indicate greater coheſion, and more intimate incorporation of its parts. For the ſame reaſon alſo the ſuperior denſity of the Saxon porcelain ought to give it the preference to the Japaneſe. Beſides, nothing would be eaſier than to give the Saxon porcelain the granulous texture of the Japaneſe, by mixing with the paſte a certain quantity of ſand. But the perſons who perfected that manufacture were certainly ſenſible that ſuch a conformity to the Japaneſe porcelain would leſſen the merit of theirs: for we know, that in general porcelains are better in proportion as they contain a larger proportion of clay or earth, and leſs of ſand, flints, or other matters of that kind.

What we have ſaid concerning porcelain in general, and the principal kinds of it, ſeems ſufficient to give juſt notions of it, if not to perſons who without conſidering the ſubject are determined to prefer the moſt ancient, to thoſe, at leaſt, who have made experiments on this ſubject, or who, having a ſufficient knowledge of chemiſtry, are capable of ſtudying and examining it thoroughly. We ſhall finiſh this article by giving a ſhort deſcription of the method of manufacturing porcelain as practiſed in Europe.

31 Of making fuſible or vitreous porcelains.

The baſis of the porcelains which we have called *fuſible*, *vitreous*, or *falſe porcelains*, is called by artiſts a *fritt*; which is nothing elſe than a mixture of ſand or of powdered flints, with ſalts capable of diſpoſing them to fuſion, and of giving them a great whiteneſs by means of a ſufficient heat. This fritt is to be then mixed with as much, and no more, of a white tenacious earth of an argillaceous or marly nature, than is ſufficient to make it capable of being worked upon the wheel. The whole mixture is to be well ground together in a mill, and made into a paſte, which is to be formed, either upon the wheel or in moulds, into pieces of ſuch forms as are required.

Each of theſe pieces, when dry, is to be put into a caſe made of earthen ware (A); which caſes are to be ranged in piles one upon another, in a furnace or kiln, which is to be filled with theſe to the roof. The furnaces are chambers or cavities of various forms and ſizes; and are ſo diſpoſed, that their fire-place is placed on the outſide oppoſite to one or more openings, which communicate within the furnace. The flame of the fuel is drawn within the furnace, the air of which rarefying, determines a current of air from without inwards, as in all furnaces. At firſt a very little fire is made, that the furnace may be heated gradually, and is to be increaſed more and more till the porcelain is baked, that is, till it has acquired its proper hardneſs and tranſparency; which is known by taking out of the furnace from time to time, and examining, ſmall pieces of porcelain, placed for that purpoſe in caſes which have lateral openings. When theſe pieces ſhow that the porcelain is ſufficiently baked, the firſt is no longer to be ſupplied with fuel, the furnace is to be cooled, and the porcelain taken out, which in this ſtate reſembles white marble not having a ſhining ſurface, which is afterwards to be given by covering them with a vitreous compoſition called the *glazing*.

32 Porcelain ſculpture.

The porcelain when baked and not glazed is called *biſcuit*, which is more or leſs beautiful according to the nature of the porcelain. The manufacture of Sévres excels all others in this reſpect, and it is therefore the only one which can produce very fine pieces of ſculpture; that is, in which all the fineneſs of the workmanſhip is preſerved, and which are preferable in ſmoothneſs and whiteneſs to the fineſt marble of Italy.

As no piece of ſculpture of this kind can preſerve all the delicacy of its workmanſhip when covered with a glazing, and as ſculptors avoid poliſhing their marble figures, becauſe the luſtre of the poliſh is diſadvantageous; therefore, in the manufactures of Sévres, all figures or little ſtatues, and even ſome ornamental vaſes, are left in the ſtate of biſcuit. The other pieces of porcelain are to be glazed in the following manner.

33 Method of glazing and colouring porcelain.

A glaſs is firſt to be compoſed ſuited to the nature of the porcelain to which it is to be applied; for every glaſs is not fit for this purpoſe. We frequently find that a glaſs which makes a fine glazing for one porcelain ſhall make a very bad glazing for another porcelain; ſhall crack in many places, ſhall have no luſtre, or ſhall contain bubbles. The glazing, then, muſt be appropriated to each porcelain, that is, to the hardneſs and denſity of the ware, and to the ingredients of its compoſition, &c.

Theſe glazings are prepared by previouſly fuſing together all the ſubſtances of which they conſiſt, ſo as to form vitreous maſſes. Theſe maſſes are to be ground very finely in a mill. This vitreous powder is to be mixed with a ſufficient quantity of water, or other proper liquor, ſo that the mixture ſhall have the conſiſtence of cream of milk. The pieces of porcelain are to be covered with a thin ſtratum of this matter; and when very dry, they are to be again put into the furnace in the ſame manner as before for the forming of the biſcuit, and to be continued there till the glazing be well fuſed. The neceſſary degree of fire for fuſing the glazing is much leſs than that for baking the paſte.

The pieces of porcelain which are intended to remain white are now finiſhed; but thoſe which are to be painted and gilded muſt undergo further operations. The colours to be applied are the ſame as thoſe uſed for enamel painting. They all conſiſt of metallic calces bruiſed and incorporated with a very fuſible glaſs. Crocus

---

(A) The caſes are called by Engliſh potters *ſeggars*. They are generally formed of coarſer clays, but which muſt be alſo capable of ſuſtaining the heat required without fuſion. By means of theſe caſes the contained porcelain is preſerved from the ſmoke of the burning fuel. The whiteneſs of the porcelain depends much on their compactneſs of texture, by which the ſmoke is excluded, and on the purity of the clay of which they are made.

Porcelain, Porch.

cus of iron furnishes a red colour; gold * precipitated by tin makes the purple and violet; copper calcined by acids and precipitated by an alkali gives a fine green; zaffre makes the blue; earths slightly ferruginous produce a yellow; and, lastly, brown and black colours are produced by calcined iron, together with a deep blue of zaffre. These colours being ground with gum-water, or with oil of spike, are to be employed for the painting of the porcelain with designs of flowers and other figures. For gilding, a powder or calx of gold is to be applied in the same manner as the coloured enamels. The painted and gilded porcelains are to be then exposed to a fire capable of fusing the glass, with which the metallic colours are mixed. Thus the colours are made to adhere, and at the same time acquire a gloss equal to that of the glazing. The gold alone has not then a shining appearance, which must be afterwards given to it by burnishing with a blood-stone.

* See Chemistry, n° 34

Preparation of unfusible porcelain.

The operations for the unfusible porcelains, and also for such as are of the nature of stone-ware, are somewhat more simple. The sands and stones which enter into their composition are to be ground in a mill: the earths or clays are to be washed: the materials are to be well mixed, and formed into a paste: the pieces are first rudely formed upon a potter's wheel; and when dry, or half dry, they are turned again upon the wheel, and their form is made more perfect: they are then placed in the furnace; not to bake them, but only to apply a sufficient heat to give them such a solidity that they may be handled without breaking, and may receive the glazing. As the pieces of porcelain after this slight heat are very dry, they imbibe water readily. This disposition assists the application of the glazing. The vitrifiable or vitrified matter of this glazing, which has been previously ground in a mill, is to be mixed with such a quantity of water, that the liquor shall have the consistence of milk. The pieces of porcelain are hastily dipt in this liquor, the water of which they imbibe, and thus on their surface is left an uniform covering of the glazing materials. This covering, which ought to be very thin, will soon become so dry, that it cannot stick to the fingers when the pieces are handled.

The pieces of this porcelain are then put into the furnace to be perfectly baked. The heat is to be raised to such a height, that all within the furnace shall be white, and the cases shall be undistinguishable from the flame. When, by taking out small pieces, the porcelain is known to be sufficiently baked, the fire is discontinued, and the furnace cooled. If the baking has been well performed, the pieces of porcelain will be found by this single operation to be rendered compact, sonorous, close-grained, moderately glossy, and covered externally with a fine glazing. The painting and gilding of this porcelain are to be executed in a manner similar to that already described.

Porcelain-Shell, a species of Cypræa.

PORCH, in architecture, a kind of vestibule supported by columns; much used at the entrance of the ancient temples, halls, churches, &c.

A porch, in the ancient architecture, was a vestibule, or a disposition of insulated columns usually crowned with a pediment, forming a covert place before the principal door of a temple or court of justice. Such is that before the door of St Paul's, Covent-Garden, the work of Inigo Jones. When a porch had four columns in front, it was called a *tetrastyle*; when six, *hexastyle*; when eight, *octostyle*, &c.

Porch || Porella.

Porch, in Greek στοα, a public portico in Athens adorned with the pictures of Polygnotus and other eminent painters. It was in this portico that Zeno the philosopher taught; and hence his followers were called *Stoics*. See Stoics and Zeno.

PORCUPINE, in zoology. See Hystrix.

Porcupine-Man, the name by which one Edward Lambert, who had a distempered skin, went in London. We have the following account of him in the Philosophical Transactions for 1755, by Mr Henry Baker, F. R. S. "He is now (says he) 40 years of age, and it is 24 years since he was first shown to the society. The skin of this man, except on his head and face, the palms of his hands, and the soles of his feet, is covered with excrescences that resemble an innumerable company of warts, of a brown colour and cylindrical figure; all rising to an equal height, which is about an inch, and growing as close as possible to each other at their basis; but so stiff and elastic as to make a rustling noise when the hand is drawn over them. These excrescences are annually shed, and renewed in some of the autumn or winter months. The new ones, which are of a paler colour, gradually rise up from beneath as the old ones fall off; and at this time it has been found necessary for him to lose a little blood, to prevent a slight sickness which he had been used to suffer before this precaution was taken. He has had the smallpox, and he has been twice salivated, in hopes to get rid of this disagreeable covering; but though just when the pustules of the smallpox had scaled off, and immediately after his salivations, his skin appeared white and smooth, yet the excrescences soon returned by a gradual increase, and his skin became as it was before. His health, during his whole life, has been remarkably good: but there is one particular of this case more extraordinary than all the rest; this man has had six children, and all of them had the same rugged covering as himself, which came on like his own about nine weeks after the birth. Of these children only one is now living, a pretty boy, who was shown with his father. It appears, therefore, as Mr Baker remarks, that a race of people might be propagated by this man, as different from other men as an African is from an Englishman; and that if this should have happened in any former age, and the accidental original have been forgotten, there would be the same objections against their being derived from the same common stock with others: it must therefore be admitted possible, that the differences now subsisting between one part of mankind and another may have been produced by some such accidental cause, long after the earth has been peopled by one common progenitor."

PORE, in anatomy, a little interstice or space between the parts of the skin, serving for perspiration.

PORELLA, in botany; a genus of the natural order of musci, belonging to the cryptogamia class of plants. The antheræ are multilocular, full of natural pores, with an operculum; there is no calyptra, nor pedicle; the capsules contain a powder like those of the other mosses; and their manner of shedding this powder is not by separating into two parts, like those of the selago and lycopodium, but by opening into several holes on all sides.

Porentru, Porism.

PORENTRU, is a town of Swifferland, in Elfgaw, and capital of the territory of the bifhop of Baſle. It has a good caſtle, where he refides. It has in it, however, nothing elſe worth taking notice of, except the cathedral. The biſhop is a prince of the empire. It is ſeated on the river Halle, near mount Jura, 22 miles ſouth of Baſle. E. Long. 7. 2. N. Lat. 47. 34.

PORISM, in geometry, is a name given by the ancient geometers to two claſſes of mathematical propoſitions. Euclid gives this name to propoſitions which are involved in others which he is profeſſedly inveſtigating, and which, although not his principal object, are yet obtained along with it, as is expreſſed by their name *poriſmata*, "acquiſitions." Such propoſitions are now called *corollaries*. But he gives the ſame name, by way of eminence, to a particular claſs of propoſitions which he collected in the courſe of his reſearches, and ſelected from among many others on account of their great ſubſerviency to the buſineſs of geometrical inveſtigation in general. Theſe propoſitions were ſo named by him, either from the way in which he diſcovered them, while he was inveſtigating ſomething elſe, by which means they might be conſidered as gains or acquiſitions, or from their utility in acquiring farther knowledge as ſteps in the inveſtigation. In this ſenſe they are poriſmata; for ποριζω ſignifies both to inveſtigate and to acquire by inveſtigation. Theſe propoſitions formed a collection, which was familiarly known to the ancient geometers by the name of Euclid's *poriſms*; and Pappus of Alexandria ſays, that it was a moſt ingenious collection of many things conducive to the analyſis or ſolution of the moſt difficult problems, and which afforded great delight to thoſe who were able to underſtand and to inveſtigate them.

Unfortunately for mathematical ſcience, however, this valuable collection is now loſt, and it ſtill remains a doubtful queſtion in what manner the ancients conducted their reſearches upon this curious ſubject. We have, however, reaſon to believe that their method was excellent both in principle and extent, for their analyſis led them to many profound diſcoveries, and was reſtricted by the ſevereſt logic. The only account we have of this claſs of geometrical propoſitions, is in a fragment of Pappus, in which he attempts a general definition of them as a ſet of mathematical propoſitions diſtinguiſhable in kind from all others; but of this diſtinction nothing remains, except a criticiſm on a definition of them given by ſome geometers, and with which he finds fault, as defining them only by an accidental circumſtance, "*Poriſma eſt quod deficit hypotheſi a theoremate locali.*"

Pappus then proceeds to give an account of Euclid's poriſms; but the enunciations are ſo extremely defective, at the ſame time that they refer to a figure now loſt, that Dr Halley confeſſes the fragment in queſtion to be beyond his comprehenſion.

The high encomiums given by Pappus to theſe propoſitions have excited the curioſity of the greateſt geometers of modern times, who have attempted to diſcover their nature and manner of inveſtigation. M. Fermat, a French mathematician of the laſt century, attaching himſelf to the definition which Pappus criticiſes, publiſhed an introduction (for this is its modeſt title) to this ſubject, which many others tried to elucidate in vain. At length Dr Simſon of Glaſgow, by patient inquiry and ſome lucky thoughts, obtained reſtoration of the poriſms of Euclid, which has all the appearance of being juſt. It preciſely correſponds to Pappus's deſcription of them. All the lemmas which Pappus has given for the better underſtanding of Euclid's propoſitions are equally applicable to thoſe of Dr Simſon, which are found to differ from local theorems preciſely as Pappus affirms thoſe of Euclid to have done. They require a particular mode of analyſis, and are of immenſe ſervice in geometrical inveſtigation; on which account they may juſtly claim our attention.

While Dr Simſon was employed in this inquiry, he carried on a correſpondence upon the ſubject with the late Dr M. Stewart, profeſſor of mathematics in the univerſity of Edinburgh; who, beſides entering into Dr Simſon's views, and communicating to him many curious poriſms, purſued the ſame ſubject in a new and very different direction. He publiſhed the reſult of his inquiries in 1746, under the title of General Theorems, not caring to give them any other name, leſt he might appear to anticipate the labours of his friend and former preceptor. The greater part of the propoſitions contained in that work are poriſms, but without demonſtrations; therefore, whoever wiſhes to inveſtigate one of the moſt curious ſubjects in geometry, will there find abundance of materials, and an ample field for diſcuſſion.

Dr Simſon defines a poriſm to be "a propoſition, in which it is propoſed to demonſtrate, that one or more things are given, between which, and every one of innumerable other things not given, but aſſumed according to a given law, a certain relation deſcribed in the propoſition is ſhown to take place."

This definition is not a little obſcure, but will be plainer if expreſſed thus: "A poriſm is a propoſition affirming the poſſibility of finding ſuch conditions as will render a certain problem indeterminate, or capable of innumerable ſolutions." This definition agrees with Pappus's idea of theſe propoſitions, ſo far at leaſt as they can be underſtood from the fragment already mentioned; for the propoſitions here defined, like thoſe which he deſcribes, are, ſtrictly ſpeaking, neither theorems nor problems, but of an intermediate nature between both; for they neither ſimply enunciate a truth to be demonſtrated, nor propoſe a queſtion to be reſolved, but are affirmations of a truth in which the determination of an unknown quantity is involved. In as far, therefore, as they aſſert that a certain problem may become indeterminate, they are of the nature of theorems; and, in as far as they ſeek to diſcover the conditions by which that is brought about, they are of the nature of problems.

We ſhall endeavour to make our readers underſtand this ſubject diſtinctly, by conſidering them in the way in which it is probable they occurred to the ancient geometers in the courſe of their reſearches: this will at the ſame time ſhow the nature of the analyſis peculiar to them, and their great uſe in the ſolution of problems.

It appears to be certain, that it has been the ſolution of problems which, in all ſtates of the mathematical ſciences, has led to the diſcovery of geometrical truths: the firſt mathematical inquiries, in particular, muſt have occurred in the form of queſtions, where ſomething was given, and ſomething required to be done; and by the reaſoning

Porifm.

reafoning neceffary to anfwer thefe queftions, or to difcover the relation between the things given and thofe to be found, many truths were fuggefted, which came afterwards to be the fubject of feparate demonftrations.

The number of thefe was the greater, becaufe the ancient geometers always undertook the folution of problems, with a fcrupulous and minute attention, infomuch that they would fcarcely fuffer any of the collateral truths to efcape their obfervation.

Now, as this cautious manner of proceeding gave an opportunity of laying hold of every collateral truth connected with the main object of inquiry, thefe geometers foon perceived, that there were many problems which in certain cafes would admit of no folution whatever, in confequence of a particular relation taking place among the quantities which were given. Such problems were faid to become impoffible: and it was foon perceived, that this always happened when one of the conditions of the problem was inconfiftent with the reft. Thus, when it was required to divide a line, fo that the rectangle contained by its fegments might be equal to a given fpace, it is evident that this was poffible only when the given fpace was lefs than the fquare of half the line; for when it was otherwife, the two conditions defining, the one the magnitude of the line, and the other the rectangle of its fegments, were inconfiftent with each other. Such cafes would occur in the folution of the moft fimple problems; but if they were more complicated, it muft have been remarked, that the conftructions would fometimes fail, for a reafon directly contrary to that juft now affigned. Cafes would occur, where the lines, which by their interfection were to determine the thing fought, inftead of interfecting each other as they did commonly, or of not meeting at all as in the above mentioned cafe of impoffibility, would coincide with one another entirely, and of courfe leave the problem unrefolved. It would appear to geometers upon a little reflection, that fince, in the cafe of determinate problems, the thing required was determined by the interfection of the two lines already mentioned, that is, by the points common to both; fo in the cafe of their coincidence, as all their parts were in common, every one of thefe points muft give a folution, or, in other words, the folutions muft be indefinite in number.

Upon inquiry, it would be found that this proceeded from fome condition of the problem having been involved in another, fo that, in fact, there was but one, which did not leave a fufficient number of independent conditions to limit the problem to a fingle or to any determinate number of folutions. It would foon be perceived, that thefe cafes formed very curious propofitions of an intermediate nature between problems and theorems; and that they admitted of being enunciated in a manner peculiarly elegant and concife. It was to fuch propofitions that the ancients gave the name of *porifms*. This deduction requires to be illuftrated by an example: fuppofe, therefore, that it were required to refolve the following problem.

Plate CCCXIII

A circle ABC (fig. 1.), a ftraight line DE, and a point F, being given in pofition, to find a point G in the ftraight line DE fuch, that GF, the line drawn from it to the given point, fhall be equal to GB, the line drawn from it touching the given circle.

Suppofe G to be found, and GB to be drawn touching the given circle ABC in B, let H be its centre, join HB, and let HD be perpendicular to DE. From D draw DL, touching the circle ABC in L, and join HL; alfo from the centre G, with the diftance GB or GF, defcribe the circle BKF, meeting HD in the points K and K′. Then HD and DL are given in pofition and magnitude; and becaufe GB touches the circle ABC, HBG is a right angle; and fince G is the centre of the circle BKF, therefore HB touches the circle BKF, and $HB^2 =$ the rectangle K′HK; which rectangle $+ DK^2 = HD^2$, becaufe K′K is bifected in D, therefore $HL^2 + KD = DH^2 = HL^2$ and $= LD^2$; therefore $DK^2 = DL^2$, and $DK = DL$; and fince DL is given in magnitude, DK is alfo given, and K is a given point: for the fame reafon K′ is a given point, and the point F being given by hypothefis, the circle BKP is given by pofition. The point G, the centre of the circle, is therefore given, which was to be found. Hence this conftruction:

Having drawn HD perpendicular to DE, and DL touching the circle ABC, make DK and DK′ each equal to DL, and find G the centre of the circle defcribed through the points K′FK; that is, let FK be joined and bifected at right angles by MN, which meets DE in G, G will be the point required; that is, if GB be drawn touching the circle ABC, and GF to the given point, GB is equal to GF.

The fynthetical demonftration is eafily derived from the preceding analyfis; but it muft be remarked, that in fome cafes this conftruction fails. For, firft, if F fall anywhere in DH, as at F′, the line MN becomes parallel to DE, and the point G is nowhere to be found; or, in other words, it is at an infinite diftance from D.—This is true in general; but if the given point F coincides with K, then MN evidently coincides with DE; fo that, agreeable to a remark already made, every point of the line DE may be taken for G, and will fatisfy the conditions of the problem; that is to fay, GB will be equal to GK, wherever the point G be taken in the line DE: the fame is true if F coincide with K. Thus we have an inftance of a problem, and that too a very fimple one, which, in general, admits but of one folution; but which, in one particular cafe, when a certain relation takes place among the things given, becomes indefinite, and admits of innumerable folutions. The propofition which refults from this cafe of the problem is a porifm, and may be thus enunciated:

"A circle ABC being given by pofition, and alfo a ftraight line DE, which does not cut the circle, a point K may be found, fuch, that if G be any point whatever in DE, the ftraight line drawn from G to the point K fhall be equal to the ftraight line drawn from G touching the given circle ABC."

The problem which follows appears to have led to the difcovery of many porifms.

A circle ABC (fig. 2.) and two points D, E, in a diameter of it being given, to find a point F in the circumference of the given circle; from which, if ftraight lines be drawn to the given points E, D, thefe ftraight lines fhall have to one another the given ratio of α to β, which is fuppofed to be that of a greater to a lefs.—Suppofe the problem refolved, and that F is found, fo that FE has to FD the given ratio of α to β, produce EF towards B, bifect the angle EFD by FL, and DFB by FM: therefore EL : LD : : EF : FD, that is in a given ratio, and fince ED is given, each of the fegments

 ments

Porism.

ments EL, LD, is given, and the point L is alfo given; becaufe DFB is bifected by FM, EM:MD : : EF:FD, that is, in a given ratio, and therefore M is given. Since DFL is half of DFE, and DFM half of DFB, therefore LFM is half of (DFE+DFB), therefore LFM is a right angle; and fince the points L, M, are given, the point F is in the circumference of a circle defcribed upon LM as a diameter, and therefore given in pofition. Now the point F is alfo in the circumference of the given circle ABC, therefore it is in the interfection of the two given circumferences, and therefore is found. Hence this conftruction: Divide ED in L, fo that EL may be to LD in the given ratio of α to β, and produce ED alfo to M, fo that EM may be to MD in the fame given ratio of α to β; bifect LM in N, and from the centre N, with the diftance NL, defcribe the femicircle LFM; and the point F, in which it interfects the circle ABC, is the point required.

The fynthetical demonftration is eafily derived from the preceding analyfis. It muft, however, be remarked, that the conftruction fails when the circle LFM falls either wholly within or wholly without the circle ABC, fo that the circumferences do not interfect; and in thefe cafes the problem cannot be folved. It is alfo obvious that the conftruction will fail in another cafe, viz. when the two circumferences LFM, ABC, entirely coincide. In this cafe, it is farther evident, that every point in the circumference ABC will anfwer the conditions of the problem, which is therefore capable of numberlefs folutions, and may, as in the former inftances, be converted into a porifm. We now inquire, therefore, in what circumftances the point L will coincide with A, and alfo the point M with C, and of confequence the circumference LFM with ABC. If we fuppofe that they coincide EA : AD : : α : β : : EC : CD, and EA : EC : : AD : CD, or by converfion EA : AC : : AD : CD—AD : : AD : 2DO, O being the centre of the circle ABC; therefore, alfo, EA : AO : : AD : DO, and by compofition EO : AO : : AO : DO, therefore $EO \times OD = AO^2$. Hence, if the given points E and D (fig. 3.) be fo fituated, that $EO \times OD = AO^2$, and at the fame time $\alpha : \beta$: : EA : AD : : EC : CD, the problem admits of numberlefs folutions; and if either of the points D or E be given, the other point, and alfo the ratio which will render the problem indeterminate, may be found. Hence we have this porifm:

Plate CCCCXIII

"A circle ABC, and alfo a point D being given, another point E may be found, fuch that the two lines inflected from thefe points to any point in the circumference ABC, fhall have to each other a given ratio, which ratio is alfo to be found." Hence alfo we have an example of the derivation of porifms from one another, for the circle ABC, and the points D and E remaining as before (fig. 3.), if, through D, we draw any line whatever HDB, meeting the circle in B and H; and if the lines EB, EH, be alfo drawn, thefe lines will cut off equal circumferences BF, HG. Let FC be drawn, and it is plain from the foregoing analyfis, that the angles DFC, CFB, are equal; therefore if OG, OB, be drawn, the angles BOC, COG, are alfo equal; and confequently the angles DOB, DOG. In the fame manner, by joining AB, the angle DBE being bifected by BA, it is evident that the angle AOF is equal to AOH, and therefore the angle FOB to HOG, that is, the arch FB to the arch HG. This propofition appears to have been the laft but one in the third book of Euclid's Porifms, and the manner of its enunciation in the porifmatic form is obvious.

The preceding propofition alfo affords an illuftration of the remark, that the conditions of a problem are involved in one another in the porifmatic or indefinite cafe; for here feveral independent conditions are laid down, by the help of which the problem is to be refolved. Two points D and E are given, from which two lines are to be inflected, and a circumference ABC, in which thefe lines are to meet, as alfo a ratio which thefe lines are to have to each other. Now thefe conditions are all independent on one another, fo that any one may be changed without any change whatever in the reft. This is true in general; but yet in one cafe, viz. when the points are fo related to one another that their rectangle under their diftances from the centre is equal to the fquare of the radius of the circle; it follows from the preceding analyfis, that the ratio of the inflected lines is no longer a matter of choice, but a neceffary confequence of this difpofition of the points.

From what has been already faid, we may trace the imperfect definition of a porifm which Pappus afcribes to the later geometers, viz. that it differs from a local theorem, by wanting the hypothefis affumed in that theorem.—Now, to underftand this, it muft be obferved, that if we take one of the propofitions called *loci*, and make the conftruction of the figure a part of the hypothefis, we get what was called by the ancient geometers a *local theorem*. If, again, in the enunciation of the theorem, that part of the hypothefis which contains the conftruction be fuppreffed, the propofition thence arifing will be a porifm, for it will enunciate a truth, and will require to the full underftanding and inveftigation of that truth, that fomething fhould be found, viz. the circumftances in the conftruction fuppofed to be omitted.

Thus, when we fay, if from two given points E, D, (fig. 3.) two ftraight lines EF, FD, are inflected to a third point F, fo as to be to one another in a given ratio, the point F is in the circumference of a given circle, we have a locus. But when converfely it is faid, if a circle ABC, of which the centre is O, be given by pofition, as alfo a point E; and if D be taken in the line EO, fo that $EO \times OD = AO^2$; and if from E and D the lines EF, DF be inflected to any point of the circumference ABC, the ratio of EF to DF will be given, viz. the fame with that of EA to AD, we have a local theorem.

Laftly, when it is faid, if a circle ABC be given by pofition, and alfo a point E, a point D may be found, fuch that if EF, FD be inflected from E and D to any point F in the circumference ABC, thefe lines fhall have a given ratio to one another, the propofition becomes a porifm, and is the fame that has juft now been inveftigated.

Hence it is evident, that the local theorem is changed into a porifm, by leaving out what relates to the determination of D, and of the given ratio. But though all propofitions formed in this way from the converfion of loci, are porifms, yet all porifms are not formed from the converfion of loci; the firft, for inftance, of the preceding cannot by converfion be changed into a locus; therefore

therefore Fermat's idea of porifms, founded upon this circumftance, could not fail to be imperfect.

To confirm the truth of the preceding theory, it may be added, that profeffor Dr Stewart, in a paper read a confiderable time ago before the Philofophical Society of Edinburgh, defines a porifm to be "A propofition affirming the poffibility of finding one or more conditions of an indeterminate theorem;" where, by an indeterminate theorem, he meant one which expreffes a relation between certain quantities that are determinate and certain others that are indeterminate; a definition which evidently agrees with the explanations which have been here given.

If the idea which we have given of thefe propofitions be juft, it follows, that they are to be difcovered by confidering thofe cafes in which the conftruction of a problem fails, in confequence of the lines which by their interfection, or the points which by their pofition, were to determine the problem required, happening to coincide with one another. A porifm may therefore be deduced from the problem to which it belongs, juft as propofitions concerning the *maxima* and *minima* of quantities are deduced from the problems of which they form limitations; and fuch is the moft natural and obvious analyfis of which this clafs of propofitions admits.

The following porifm is the firft of Euclid's, and the firft alfo which was reftored. It is given here to exemplify the advantage which, in inveftigations of this kind, may be derived from employing the *law of continuity* in its utmoft extent, and purfuing porifms to thofe extreme cafes where the indeterminate magnitudes increafe *ad infinitum*.

This porifm may be confidered as having occurred in the folution of the following problem: Two points A, B, (fig. 4.) and alfo three ftraight lines DE, FK, KL, being given in pofition, together with two points H and M in two of thefe lines, to inflect from A and B to a point in the third, two lines that fhall cut off from KF and KL two fegments, adjacent to the given points H and M, having to one another the given ratio of α to β. Now, to find whether a porifm be connected with this problem, fuppofe that there is, and that the following propofition is true. Two points A and B, and two ftraight lines DE, FK, being given in pofition, and alfo a point H in one of them, a line LK may be found, and alfo a point in it M, both given in pofition, fuch that AE and BE inflected from the points A and B to any point whatever of the line DE, fhall cut off from the other lines FK and LK fegments HG and MN adjacent to the given points H and M, having to one another the given ratio of α to β.

Plate CCXIII

Firft, let AE′, BE′, be inflected to the point E′, fo that AE′ may be parallel to FK, then fhall E′B be parallel to KL, the line to be found; for if it be not parallel to KL, the point of their interfection muft be at a finite diftance from the point M, and therefore making as β to α; fo this diftance to a fourth proportional, the diftance from H at which AE′ interfects FK, will be equal to that fourth proportional. But AE′ does not interfect FK, for they are parallel by conftruction; therefore BE′ cannot interfect KL, which is therefore parallel to BE′, a line given in pofition. Again, let AE″, BE″, be inflected to E″, fo that AE″ may pafs through the given point H: then it is plain that BE″ muft pafs through the point to be found M; for if not, it may be demonftrated juft as above, that AE″ does not pafs through H, contrary to the fuppofition. The point to be found is therefore in the line E″B, which is given in pofition. Now if from E there be drawn EP parallel to AE′, and ES parallel to BE′, BS : SE : : BL : $LN=\frac{SE\times BL}{BS}$, and $AP:PE::AF:FG=\frac{PE\times AF}{AP}$; therefore $FG:LN::\frac{PE\times AF}{AP}:\frac{SE\times BL}{BS}::PE\times AF \times BS:SE\times BL\times AP$; wherefore the ratio of FG to LN is compounded of the ratios of AF to BL, PE to ES, and BS to AP; but PE : SE : : AE′ : BE′, and BS : AP : : DB : DA for DB : BS : : DE′ : E′E : : DA : AP; therefore the ratio of FG to LN is compounded of the ratios of AF to BL, AE′ to BE′, and DB to DA. In like manner, becaufe E″ is a point in the line DE and AE″, BE″ are inflected to it, the ratio of FH to LM is compounded of the fame ratios of AF to BL, AE′ to BE′, and DB to DA; therefore FH : LM : : FG : NL (and confequently) : : HG : MN; but the ratio of HG to MN is given, being the fame as that of α to β; the ratio of FH to LM is therefore alfo given, and FH being given, LM is given in magnitude. Now LM is parallel to BE′, a line given in pofition; therefore M is in a line QM, parallel to AB, and given in pofition; therefore the point M, and alfo the line KLM, drawn through it parallel to BE′, are given in pofition, which were to be found. Hence this conftruction: From A draw AE′ parallel to FK, fo as to meet DE in E′; join BE′, and take in it BQ, fo that $\alpha:\beta::HF:BQ$, and through Q draw QM parallel to AB. Let HA be drawn, and produced till it meet DE in E″, and draw BE″, meeting QM in M; through M draw KML parallel to BE′, then is KML the line and M the point which were to be found. There are two lines which will anfwer the conditions of this porifm; for if in QB, produced on the other fide of B, there be taken $Bq=BQ$, and if $q\,m$ be drawn parallel to AB, cutting MB in m; and if $m\,\lambda$ be drawn parallel to BQ, the part $m\,n$, cut off by EB produced, will be equal to MN, and have to HG the ratio required. It is plain, that whatever be the ratio of α to β, and whatever be the magnitude of FH, if the other things given remain the fame, the lines found will be all parallel to BE′. But if the ratio of α to β remain the fame likewife, and if only the point H vary, the pofition of KL will remain the fame, and the point M will vary.

Another general remark which may be made on the analyfis of porifms is, that it often happens, as in the laft example, that the magnitudes required may all, or a part of them, be found by confidering the extreme cafes; but for the difcovery of the relation between them, and the indefinite magnitudes, we muft have recourfe to the hypothefis of the porifm in its moft general or indefinite form; and muft endeavour fo to conduct the reafoning, that the indefinite magnitudes may at length totally difappear, and leave a propofition afferting the relation between determinate magnitudes only.

For this purpofe Dr Simfon frequently employs two ftatements of the general hypothefis, which he compares together. As for inftance, in his analyfis of the laft po-

 rifm,

Porism

riſm, he aſſumes not only E, any point in the line DE, but alſo another point O, anywhere in the ſame line, to both of which he ſuppoſes lines to be inflected from the points A, B. This double ſtatement, however, cannot be made without rendering the inveſtigation long and complicated; nor is it even neceſſary, for it may be avoided by having recourſe to ſimpler *poriſms*, or to *loci*, or to propoſitions of the *data*. The following poriſm is given as an example where this is done with ſome difficulty, but with conſiderable advantage both with regard to the ſimplicity and ſhortneſs of the demonſtration. It will be proper to premiſe the following lemma.

Plate CCCCXIII

Let AB (fig. 7.) be a ſtraight line, and D, L any two points in it, one of which D is between A and B; let CL be any ſtraight line. $\frac{LB}{CL}\cdot AD^2+\frac{LA}{CL}\cdot BD^2=\frac{LB}{CL}\cdot AL^2+\frac{LA}{CL}\cdot BL^2+\frac{AB}{CL}\cdot DL^2$. Place CL perpendicular to AB, and through the points A, C, B, deſcribe a circle; and let CL meet it again in E, and join AE, BE. Draw DG parallel to CE, meeting AE and BE in H and G. Draw EK parallel to AB. $CL : LB :: (LA : LE ::)\ LA^2 : LA\times LE=\frac{LB}{CL}\cdot LA^2$ $CL : LA :: (LB : LE ::)\ LB^2 : LB\times LE=\frac{LA}{CL}\cdot BL^2$. Now $CL : LB :: LA : LE :: (EK)\ LD : KH$, and $CL : LA :: LB : LE :: (EK)\ LD : KG$; therefore, (V. 24.) $CL : AB :: (LD : GH ::)\ LD^2 : EK\times GH=\frac{AB}{CL}\cdot LD^2$; therefore $\frac{LB}{CL}\cdot LA^2+\frac{LA}{CL}\cdot L\vdash \frac{AB}{CL}\cdot LD^2=AB\times LE+EK\times GH$. Again, $CL : LA :: (LB : LE :: DB : DG ::)\ DB^2 : DB\times DG=\frac{LA}{CL}\cdot DB^2$, and $CL : LB :: (LA : LE :: DA : DH ::)\ DA^2 : DA\times DH=\frac{LB}{CL}\cdot DA^2$; therefore $\frac{LB}{CL}DA^2+\frac{LA}{CL}DB^2=AD\times DH+DB\times DG=AB\times LE+EK\times GH$; wherefore $\frac{LB}{CL}DA^2+\frac{LA^2}{CL}DB^2=\frac{LB}{CL}LA^2+\frac{LA}{CL}LB^2+\frac{AB}{CL}LD^2$. *Q. E. D.*

Let there be three ſtraight lines AB, AC, CB given in poſition (fig. 5.); and from any point whatever in one of them, as D, let perpendiculars be drawn to the other two, as DF, DE, a point G may be found, ſuch, that if GD be drawn from it to the point D, the ſquare of that line ſhall have a given ratio to the ſum of the ſquares of the perpendiculars DF and DE, which ratio is to be found.

Draw AH, BK perpendicular to BC and AC; and in AB take L, ſo that $AL : LB :: AH^2 : BK^2 :: AC^2 : CB^2$. The point L is therefore given; and if N be taken, ſo as to have to AL the ſame ratio that AB^2 has to AH^2, N will be given in magnitude. Alſo, ſince $AH^2 : BK^2 :: AL : LB$, and $AH^2 : AB^2 :: AL : N$, *ex equo* $BK^2 : AB^2 :: LB : N$. Draw LO, LM perpendicular to AC, CB; LO, LM are therefore given in magnitude. Now, becauſe $BA^2 : BK^2 :: AD^2 : DF^2$, $N : LB :: AD^2 : DF^2$, and $DF^2=\frac{LB}{N}\cdot AD^2$; and for the ſame reaſon $DE^2=\frac{AL}{N}\cdot BD^2$; but, by the preceding lemma, $\frac{LB}{N}\cdot AD^2+\frac{AL}{N}\cdot BD^2=\frac{LB}{N}\cdot AL^2+\frac{AL}{N}\cdot BL^2+\frac{AB}{N}\cdot DL^2$; that is, $DE^2+DF^2=LO^2+LM^2+\frac{AB}{N}\cdot DL^2$. Join LG then by hypotheſis LO^2+LM^2, as to LG^2, the ſame ratio as DF^2+DE^2 has to DG^2; let it be that of R to N, then $LO^2+LM^2=\frac{R}{N}\cdot LG^2$; and therefore $DE^2+DF^2=\frac{R}{N}\cdot LG^2+\frac{AB}{N}\cdot DL^2$; but $DE^2+DF^2=\frac{R}{N}\cdot DG^2$; therefore, $\frac{R}{N}\cdot LG^2+\frac{BA}{N}\cdot DL^2=\frac{R}{N}\cdot DG^2$, and $\frac{AB}{N}\cdot DL^2=\frac{R}{N}(DG^2-LG^2)$; therefore DG^2-LG^2 has to DL^2 a conſtant ratio, viz. that of AB to R. The angle DLG is therefore a right angle, and the ratio of AB to R that of equality, otherwiſe LD would be given in magnitude, contrary to the ſuppoſition. LG is therefore given in poſition: and ſince $R : N :: AB : N :: LO^2+LM^2 : LG^2$; therefore the ſquare of LG, and conſequently LG, is given in magnitude. The point G is therefore given, and alſo the ratio of DE^2+DF^2 to DG^2, which is the ſame with that of AB to N.

The conſtruction eaſily follows from the analyſis, but it may be rendered more ſimple; for ſince $AH^2 : AB^2 :: AL : N$, and $BK^2 : AB^2 :: BL : N$; therefore $AH^2+BK^2 : AB^2 :: AB : N$. Likewiſe, if AG, BG, be joined, $AB : N :: AH^2 : AG^2$, and $AB : N :: BK^2 : BG^2$; wherefore $AB : N :: AK^2+BK^2 : AG^2+BG^2$ and $AG^2+BG^2=AB^2$; therefore the angle AGB is a right one, and $AL : LG :: LG : LB$. If therefore AB be divided in L, ſo that $AL : LB :: AH^2 : BK^2$; and if LG, a mean proportional between AL and LB, be placed perpendicular to AB, G will be the point required.

The ſtep in the analyſis, by which a ſecond introduction of the general hypotheſis is avoided, is that in which the angle GLD is concluded to be a right angle; which follows from DG^2-GL^2, having a given ratio to LD^2, at the ſame time that LD is of no determinate magnitude. For, if poſſible, let GLD be obtuſe (fig. 6.), and let the perpendicular from G to AB meet it in V, therefore V is given: and ſince $GD^2-LG^2=LD^2+2DL\times LV$; therefore, by the ſuppoſition, $LD^2+2DL\times LV$ muſt have a given ratio to LD^2; therefore the ratio of LD^2 to $DL\times VL$, that is, of LD to VL, is given, ſo that VL being given in magnitude, LD is alſo given. But this is contrary to the ſuppoſition; for LD is indefinite by hypotheſis, and therefore GLD cannot be obtuſe, nor any other than a right angle. The concluſion here drawn immediately from the indetermination of LD would be deduced, according to Dr Simſon's method, by aſſuming another point D′ any how, and from the ſuppoſition that $GD'^2-GL^2 : LD'^2 :: GD^2-GL^2 : LD^2$, it would eaſily appear that GLD muſt be a right angle, and the ratio that of equality.

Theſe poriſms facilitate the ſolution of the general problems from which they are derived. For example, let three ſtraight lines AB, AC, BC (fig. 5.), be given in poſi-

Porism.

position, and also a point R, to find a point D in one of the given lines, so that DE and DF being drawn perpendicular to BC, AC, and DR, joined; DE^2+DF^2 may have to DR^2 a given ratio. It is plain, that having found G, the problem would be nothing more than to find D, such that the ratio of GD^2 to DR^2, and therefore that of GD to DR, might be given, the point D being in the circumference of a given circle, as is well known to geometers.

The same porism also assists in the solution of another problem. For if it were required to find D such that DE^2+DF^2 might be a given space; having found G, DG^2 would have to DE^2+DF^2 a given ratio, and DG would therefore be given; whence the solution is obvious.

The connection of this porism with the impossible case of the problem is evident; the point L being that from which, if perpendiculars be drawn to AC and CB, the sum of their squares is the least possible. For since $DF^2+DE^2 : DG^2 :: LO^2+LM^2 : LG^2$; and since LG is less than DG, LO^2+LM^2 must be less than DF^2+DE^2. It is evident from what has now appeared, that in some instances at least there is a close connection between these propositions and the *maxima* or *minima*, and of consequence the impossible cases of problems. The nature of this connection requires to be farther investigated, and is the more interesting because the transition from the indefinite to the impossible case seems to be made with wonderful rapidity. Thus in the first proposition, though there be not properly speaking an impossible case, but only one where the point to be found goes off *ad infinitum*, it may be remarked, that if the given point F be anywhere out of the line HD (fig. 1.), the problem of drawing GB equal to GF is always possible, and admits of just one solution; but if F be in DH, the problem admits of no solution at all, the point being then at an infinite distance, and therefore impossible to be assigned. There is, however, this exception, that if the given point be at K in this same line, DH is determined by making DK equal to DL. Then every point in the line DE gives a solution, and may be taken for the point G. Here therefore the case of numberless solutions, and of no solution at all, are as it were *conterminal*, and so close to one another, that if the given point be at K the problem is indefinite; but if it remove ever so little from K, remaining at the same time in the line DH, the problem cannot be resolved. This affinity might have been determined *à priori*: for it is, as we have seen, a general principle, that a problem is converted into a porism when one or when two of the conditions of it necessarily involve in them some one of the rest. Suppose, then, that two of the conditions are exactly in that state which determines the third; then while they remain fixed or given, should that third one vary or differ ever so little from the state required by the other two, a contradiction will ensue: therefore if, in the hypothesis of a problem, the conditions be so related to one another as to render it indeterminate, a porism is produced; but if, of the conditions thus related to one another, some one be supposed to vary, while the others continue the same, an absurdity follows, and the problem becomes impossible. Wherever, therefore, any problem admits both of an indeterminate and an impossible case, it is certain, that these cases are nearly related to one another, and that some of the conditions by which they are produced are common to both." It is supposed above, that *two* of the conditions of a problem involve in them a third; and wherever that happens, the conclusion which has been deduced will invariably take place. But a porism may in some cases be so simple as to arise from the mere coincidence of *one* condition with another, though in no case whatever any inconsistency can take place between them. There are, however, comparatively few porisms so simple in their origin, or that arise from problems where the conditions are but little complicated; for it usually happens that a problem which can become indefinite may also become impossible; and if so, the connection already explained never fails to take place.

Plate CCXIII

Another species of impossibility may frequently arise from the porismatic case of a problem which will affect in some measure the application of geometry to astronomy, or any of the sciences depending on experiment or observation. For when a problem is to be resolved by help of data furnished by experiment or observation, the first thing to be considered is, whether the data so obtained be sufficient for determining the thing sought; and in this a very erroneous judgment may be formed, if we rest satisfied with a general view of the subject; for tho' the problem may in general be resolved from the data with which we are provided, yet these data may be so related to one another in the case under consideration, that the problem will become indeterminate, and instead of one solution will admit of an indefinite number. This we have already found to be the case in the foregoing propositions. Such cases may not indeed occur in any of the practical applications of geometry; but there is one of the same kind which has actually occurred in astronomy. Sir Isaac Newton, in his *Principia*, has considered a small part of the orbit of a comet as a straight line described with an uniform motion. From this hypothesis, by means of four observations made at proper intervals of time, the determination of the path of the comet is reduced to this geometrical problem: Four straight lines being given in position, it is required to draw a fifth line across them, so as to be cut by them into three parts, having given ratios to one another. Now this problem had been constructed by Dr Wallis and Sir Christopher Wren, and also in three different ways by Sir Isaac himself in different parts of his works; yet none of these geometers observed that there was a particular situation of the lines in which the problem admitted of innumerable solutions: and this happens to be the very case in which the problem is applicable to the determination of the comet's path, as was first discovered by the Abbé Boscovich, who was led to it by finding, that in this way he could never determine the path of a comet with any degree of certainty.

Besides the geometrical there is also an algebraical analysis belonging to porisms; which, however, does not belong to this place, because we give this account of them merely as an article of ancient geometry; and the ancients never employed algebra in their investigations. Mr Playfair, professor of mathematics in the university of Edinburgh, has written a paper on the origin and geometrical investigation of porisms, which is published in the third volume of the Transactions of the Royal Society of Edinburgh, from which this account of the

 subject

subject is taken. He has there promised a second part to his paper, in which the algebraical investigation of porisms is to be considered. This will no doubt throw considerable light upon the subject, as we may readily judge from that gentleman's known abilities, and from the specimen he has already given us in the first part.

PORK, the flesh of swine killed for the purposes of food. See Sus.

The hog is the only domestic animal that we know of no use to man when alive, and therefore seems properly designed for food. Besides, as loathsome and ugly to every human eye, it is killed without reluctance. The Pythagoreans, whether to preserve health, or on account of compassion, generally forbade the use of animal food; and yet it is alleged that Pythagoras reserved the use of hog's flesh for himself. The Jews, the Egyptians, &c. and other inhabitants of warm countries, and all the Mahometans at present, reject the use of pork. It is difficult to find a satisfactory reason for this, or for the precept given to the Jews respecting it, tho' unquestionably there was some good one for it. The Greeks gave great commendations to this food; and Galen, though indeed that is suspected to be from a particular fondness, is everywhere full of it. The Romans considered it as one of their delicacies; and if some of the inhabitants of the northern climates have taken an aversion to it, that probably arose from the uncultivated state of their country not being able to rear it. Pork is of a very tender structure; increased perhaps from a peculiarity in its œconomy, viz. taking on fat more readily than any other animal. Pork is a white meat even in its adult state, and then gives out a jelly in very great quantity. On account of its little perspirability and tenderness it is very nutritious, and was given for that intention to the *athletæ*. With regard to its alkalescency, no proper experiments have yet been made; but as it is of a gelatinous and succulent nature, it is probably less so than many others. Upon the whole, it appears to be a very valuable nutriment; and the reason is not very obvious why it was in some countries forbid. It is said that this animal is apt to be diseased; but why were not inconveniences felt on that account in Greece? Again, it has been alleged, that as Palestine would not rear these animals, and as the Jews had learned the use of them in Egypt, it was necessary they should have a precept to avoid them. But the Egyptians themselves did not use this meat; and this religious precept, indeed, as well as many others, seems to have been borrowed from them. Possibly, as pork is not very perspirable, it might increase the leprosy, which was said to be epidemic in Palestine; though this is far from being certain.

Cullen's Mat. Med.

PORLOCK, in the county of Somerset in England, is a small sea-port town six miles west from Minehead. This whole parish, including hamlets, contains about 110 houses, and nearly 600 inhabitants. The situation of the town is very romantic, being nearly surrounded on all sides, except toward the sea, by steep and lofty hills, intersected by deep vales and hollow glens. Some of the hills are beautifully wooded, and contain numbers of wild deer. The valleys are very deep and picturesque; the sides being steep, scarred with wild rocks, and patched with woods and forest shrubs. Some of them are well cultivated and studded with villages or single farms and cottages, although agriculture here is very imperfectly understood. Most of the roads and fields are so steep, that no carriages of any kind can be used; all the crops are therefore carried in with crooks on horses, and the manure in wooden pots called *dossels*. Many of the poor are employed in spinning yarn for the Dunster manufactory. W. Long. 3. 32. N. Lat. 51. 14.

PORO. See Calauria.

PORPESSE, in ichthyology. See Delphinus.

PORPHYRIUS, a famous Platonic philosopher, was born at Tyre in 233, in the reign of Alexander Severus. He was the disciple of Longinus, and became the ornament of his school at Athens; from thence he went to Rome, and attended Plotinus, with whom he lived six years. After Plotinus's death he taught philosophy at Rome with great applause; and became well skilled in polite literature, geography, astronomy, and music. He lived till the end of the third century, and died in the reign of Dioclesian. There are still extant his book on the Categories of Aristotle; a Treatise on Abstinence from Flesh; and several other pieces in Greek. He also composed a large treatise against the Christian religion, which is lost. That work was answered by Methodius bishop of Tyre, and also by Eusebius, Apollinarius, St Augustin, St Jerome, St Cyril, and Theodoret. The emperor Theodosius the Great caused Porphyrius's book to be burned in 338. Those of his works that are still extant were printed at Cambridge in 1655, 8vo, with a Latin version.

"Porphyrius (says Dr Enfield) was, it must be owned, a writer of deep erudition; and had his judgment and integrity been equal to his learning, he would have deserved a distinguished place among the ancients. But neither the splendor of his diction, nor the variety of his reading, can atone for the credulity or the dishonesty which filled the narrative parts of his works with so many extravagant tales, or interest the judicious reader in the abstruse subtelties and mystical flights of his philosophical writings."

PORPHYRY, a genus of stones belonging to the order of saxa. It is found of several different colours, as green, deep red, purple, black, dark-brown, and grey. Under the name of *porphyry*, Mr Kirwan and M. de Saussure include those stones which contain either felt-spar, schoerl, quartz, or mica, with other species of crystallized stone on a siliceous or calcareous ground. There are a great many different kinds. M. Ferber describes 20 varieties under four species, but in general it is considered with relation to its ground, which is met with of the colours already mentioned. When the ground is of jasper, the porphyry is commonly very hard; the red generally contains felt-spar in small white dots or specks; and frequently, together with these, black spots of schoerl. The green is often magnetic, and is either a jasper or schoerl, with spots of quartz. Sometimes a porphyry of one colour contains a fragment of another of a different colour. Those that have chert for their ground are fusible *per se*. The calcareous porphyry consists of quartz, felt-spar, and mica, in separate grains, united by a calcareous cement; and, lastly, the micaceous porphyry consists of a greenish grey micaceous ground, in which red felt-spar and greenish soap-rock are inserted.

The porphyry of the ancients is a most elegant mass of an extremely firm and compact structure, remarkably heavy, and of a fine strong purple, variegated more or

Porphyry. less with pale red and white; its purple is of all degrees, from the claret-colour to that of the violet; and its variegations are rarely disposed in veins, but spots, sometimes very small, and at others running into large blotches. It is less fine than many of the ordinary marbles; but it excels them all in hardness, and is capable of a most elegant polish. It is still found in immense strata in Egypt. The hard red-lead coloured porphyry, variegated with black, white, and green, is a most beautiful and valuable substance. It has the hardness and all the other characters of the oriental porphyry; and even greatly excels it in brightness, and in the beauty and variegation of its colours. It is found in great plenty in the island of Minorca; and is well worth importing, being greatly superior to all the Italian marbles. The hard, pale-red porphyry, variegated with black, white, and green, is of a pale flesh-colour; often approaching to white. It is variegated in blotches from half an inch to an inch broad. It takes a high polish, and emulates all the qualities of the oriental porphyry. It is found in immense strata in Arabia Petræa, and in the Upper Egypt; and in separate nodules in Germany, England, and Ireland.

Ficoroni takes notice of two exquisitely fine columns of black porphyry in a church at Rome. In Egypt there are three celebrated obelisks or pillars of porphyry, one near Cairo and two at Alexandria. The French call them *aguglias*, and in England they are called *Cleopatra's needles*.

The art of cutting porphyry, practised by the ancients, appears now to be lost. Indeed it is difficult to conceive what tools they used for fashioning those huge columns and other porphyry works in some of the ancient buildings in Rome. One of the most considerable of these, still entire, is a tomb of Constantia, the emperor Constantine's daughter. It is in the church of St Agnes, and is commonly called *the tomb of Bacchus*. In the palace of the Thuilleries there is also a bust of Apollo and of twelve emperors, all in porphyry. Some ancient pieces seem to have been wrought with the chissel, others with the saw, others with wheels, and others gradually ground down with emery. Yet modern tools will scarce touch porphyry. Dr Lister therefore thinks*, that the ancients had the secret of tempering steel better than we; and not, as some imagine, that they had the art of softening the porphyry; though it is probable that time and air have contributed to increase its hardness. Mr Addison says, he saw a workman at Rome cutting porphyry; but his advances were extremely slow and almost insensible. The Italian sculptors work the pieces of old porphyry columns still remaining (for the porphyry quarries are long since lost) with a brass saw without teeth. With this saw, emery, and water, they rub and wear the stone with infinite patience. Many persons have endeavoured to retrieve the ancient art, and particularly Leon Baptista Alberti; who, searching for the necessary materials for temper, says, he found goats blood the best of any: but even this availed not much; for in working with chissels tempered with it, sparks of fire came much more plentifully than pieces of the stone. The sculptors were thus, however, able to make a flat or oval form; but could never attain to any thing like a figure.

* *Philosoph. Transact.* n° 203. or Lowth's *Abrid.* vol. ii. p. 560.

In the year 1555, Cosmo de Medicis is said to have distilled a water from certain herbs, with which his sculptor Francesco Tadda gave his tools such an admirable hardness and so fine a temper, that he performed some very exquisite works with them; particularly our Saviour's head in demi-relievo, and Cosmo's head and his duchess's. The very hair and beard, how difficult soever, are here well conducted; and there is nothing of the kind superior to it in all the works of the ancients; but the secret appears to have died with him. The French have discovered another mode of cutting porphyry, *viz.* with an iron saw without teeth, and *grez*, a kind of free stone pulverized, and water. The authors of this invention say, that they could form the whole contour of a column hereby if they had matter to work on. Others have proposed to harden tools so as to cut porphyry, by steeping them in the juice of the plant called *bear's beech* or *brankursine*. See Birch's *Hist.* R. S. vol. i. p. 238. vol. ii. p. 73, &c. Mr Boyle says, that he caused porphyry to be cut by means of emery, steel saws, and water; and observes, that in his time the English workmen were ignorant of the manner of working porphyry, and that none of them would undertake to cut or polish it. See his Works abr. vol. i. p. 111.

Da Costa supposes, and perhaps with reason, that the method used by the ancients in cutting and engraving porphyry was extremely simple, and that it was performed without the aid of any scientific means that are now lost. He imagines, that, by unwearied diligence, and with numbers of common tools at great expence, they rudely hewed or broke the stone into the intended figure, and by continued application reduced them into more regular designs; and that they completed the work by polishing it with great labour, by the aid of particular hard sands found in Egypt. And he thinks, that in the porphyry quarries there were layers of grit or loose disunited particles, analogous to the porphyry, which they carefully sought for, and used for this work. See *Nat. Hist. of Fossils*, p. 285.

Porphyry-Shell, a species of Murex.

PORPITES, the Hair-button stone, in natural history, a name given by authors to a small species of fossil coral; which is usually of a rounded figure considerably flatted, and striated from the centre everyway to the circumference. These are of different sizes and of different colours, as greyish, whitish, brownish, or bluish, and are usually found immersed in stone. See Plate CC.

PORRUM, the Leek; a species of plants, belonging to the genus of Allium.

Porphyry ‖ Port.

PORT, a harbour, river, or haven, formed either by nature or art to receive and shelter shipping from the storms and waves of the open sea.

Artificial ports are those which are either formed by throwing a strong mound or rampire across the harbour's mouth to some island or rock, or erecting two long barriers, which stretch from the land on each side like arms or the horns of a crescent, and nearly inclose the haven; the former of these are called *mole-heads* and the latter *piers*.

Port, is also a name given on some occasions to the larboard or left side of the ship, as in the following instances. Thus it is said, "the ship heels to port," *i. e.* stoops or inclines to the larboard-side. "Top the yard to port!" the order to make the larboard extremity of a yard higher than the other. "Port the helm!" the order

order to put the helm over to the larboard-side of the vessel. In all these senses this phrase appears intended to prevent any mistakes happening from the similarity of sounds in the words *starboard* and *larboard*, particularly when they relate to the helm, where a misapprehension might be attended with very dangerous consequences.

Ports, the embrasures or openings in the side of a ship of war, wherein the artillery is ranged in battery upon the decks above and below.

The ports are formed of a sufficient extent to point and fire the cannon, without injuring the ship's side by the recoil; and as it serves no end to enlarge them beyond what is necessary for that purpose, the shipwrights have established certain dimensions, by which they are cut in proportion to the size of the cannon.

The ports are shut in at sea by a sort of hanging-doors called the *port-lids;* which are fastened by hinges to their upper edges, so as to let down when the cannon are drawn into the ship. By this means the water is prevented from entering the lower decks in a turbulent sea. The lower and upper edges of the ports are always parallel to the deck, so that the guns, when levelled in their carriages, are all equally high above the lower extremity of the ports, which is called the *port-cells*.

Port, is also a strong wine brought from Port-a-port, and also called *Porto* and *Oporto*.

Port of the Voice, in music, the faculty or habit of making the shakes, passages, and diminutions, in which the beauty of a song or piece of music consists.

Port-Crayon, a pencil-case, which is usually four or five inches long, and contrived so as that the pencil may slide up and down. Its inside is round, and its outside is sometimes filed into eight sides or faces, on which are drawn the sector-lines; sometimes it is made round both without-side and within, and has its length divided into inches and parts of inches.

Port-Fire, a composition for setting fire to powder, &c. Port-fires are frequently used by artillery people in preference to matches; and they are distinguished into wet and dry port-fires. The composition of the former is saltpetre four, sulphur one, and mealed powder four. When these materials are thoroughly mixed and sifted, the whole is to be moistened with a little linseed oil, and rubbed between the hands till all the oil is imbibed by the composition. The preparation for dry port-fires is saltpetre four, sulphur one, mealed powder two, and antimony one. These compositions are driven into small paper cases, to be used whenever necessary.

Port-aux-Prune, so called by the French, is a country on the coast of Africa, to the north of the island of Madagascar. It is a rich country, and fertile in rice and pastures; it is inhabited only by the negroes, who are an industrious good sort of people, but very superstitious. There are no towns, but several villages, and they have some customs which seem to incline to Judaism.

Port-Jackson, in New Holland. See *New Holland*, n° 7, &c.

Port-Royal, a sea-port town in the island of Jamaica. It was once a place of the greatest riches and importance in the West Indies: but in 1692 it was destroyed by an earthquake, in 1702 by fire, in 1722 by an inundation of the sea, and in 1744 it suffered greatly by a hurricane. It is now reduced to three streets, a few lanes, and about 200 houses. It contains the royal navy-yard for heaving down and refitting the king's ships; the navy-hospital, and barracks for a regiment of soldiers. The fortifications, which are very extensive, being in excellent order, and having been lately strengthened with many additional works, it may be said to vie in point of strength with any fortress in the king's dominions. The harbour is one of the best in the world, and 1000 ships may ride therein, secure from every wind that can blow. It is six miles east of Spanish-town, and as much by water south-east of Kingston. W. Long. 76. 40. N. Lat. 18. 0.

Port-Royal, an island in North America, on the coast of South Carolina, which, with the neighbouring continent, forms one of the most commodious harbours in the British plantations. It is 15 miles in length; and the town on the north shore is called *Beaufort*. W. Long. 80. 10. N. Lat. 31. 40.

Port-Royal, the name of two monasteries of Cistertian nuns in the diocese of Paris; the one near Chevreuse, at the distance of five leagues from Paris, called *Port-Royal of the Fields;* and the other in Paris, in the suburbs of St James.

The nuns of the former of these monasteries proving refractory, were dispersed; when many ecclesiastics, and others, who were of the same sentiments as these religious, retired to Port-Royal, took apartments there, and printed many books. Hence the name of *Port-Royalists* was given to all their party, and their books were called *books of Port-Royal:* from hence we say the writers of Port-Royal, Messieurs de Port-Royal, and the translations and grammars of Port-Royal.

PORTA, or *Vena Porta*, in anatomy, a large vein distributed through the liver in the manner of an artery. See Anatomy, n° 96.

Porta-Angusta (anc. geog.), mentioned only by Ptolemy; a town of the Vaccæi in the Hither Spain; thought by some to be *Torre Quemada*, in Old Castile; by others *Los Valvases*, a village between Burgos and Torre Quemada.

PORTÆ-Romanæ (anc. geog.), according to Pliny, Romulus left but three, or at most four, gates of Rome: afterwards, on enlarging the Pomœria, or compass of the city, they amounted to 37.

PORTAL, in architecture, a little gate where there are two gates of a different bigness; also a little square corner of a room cut off from the rest by the wainscot, and forming a short passage into the room. The same name is also sometimes given to a kind of arch of joiners work before a door.

PORTATE, or a *Cross Portate*, in heraldry, a cross which does not stand upright, as crosses generally do; but lies across the escutcheon in bend, as if it were carried on a man's shoulder.

PORTCULLICE, in fortification, is an assemblage of several large pieces of wood, joined across one another like a harrow, and each pointed with iron at the bottom. They are sometimes hung over the gate-way of old fortified towns, ready to let down in case of surprise, when the gates could not be shut.

PORTER, a kind of malt-liquor which differs from ale and pale beer, in its being made with high dried malt. See Ale, Beer, and Brewing.

PORT-

PORT-Glasgow. See Glasgow, n° 10.

PORTGREVE, or Portgrave, was anciently the principal magiſtrate in ports and other maritime towns. The word is formed from the Saxon *port*, "a port or other town;" and *geref*, "a governor."—It is ſometimes alſo written *port-reve*.

Camden obſerves, that the chief magiſtrate of London was anciently called *port-greve:* inſtead of whom, Richard I. ordained two bailiffs; and ſoon afterwards King John granted them a mayor for their yearly magiſtrate.

PORTICI, a palace of the king of Naples, ſix miles from that capital. It has a charming ſituation, on the ſea-ſide, near mount Veſuvius. It is enriched with a vaſt number of fine ſtatues, and other remains of antiquity, taken out of the ruins of Herculaneum.

The muſeum conſiſts of 16 rooms, in which the different articles are arranged with very great taſte. The floors are paved with Moſaic, taken from the recovered towns, and the walls of the court are lined with inſcriptions. Beſides buſts, ſtatues, medals, intaglios, lamps, and tripods, there is ſcarcely an article uſed by the ancients of which a ſpecimen may not be ſeen in this muſeum. "But the moſt valuable room is the library, from the numerous manuſcript rolls which it contains. What a field is here for conjecture! what room for hope! Among this ineſtimable collection, how many great works are there, of which even the names are now unknown! how many unbroken volumes, whoſe very fragments, preſerved in the writings of the ancient ſcholiaſts, convey to us moral improvement, information, and delight! perhaps all the dramatic pieces of Menander and Philemon; perhaps, nay, certainly, the loſt Decades of Livy; for it is impoſſible to ſuppoſe, that among ſo many rolls, the moſt admired hiſtory of the people who poſſeſſed them is not to be found: what private library in Britain is without the beſt hiſtories of England? But how I tremble for their ſituation, as Portici is built on the lava that overwhelmed Herculaneum! How I tremble too for the indifference of the king of Naples towards this invaluable treaſure, in which all the moſt enlightened people of Europe are deeply intereſted! When I firſt ſaw them, I had no idea of what they were, as they reſemble wooden truncheons burnt almoſt to charcoal. They are ſo hard and brittle, that the greateſt caution muſt be uſed in removing them, leſt they crumble to duſt; nevertheleſs, an ingenious friar of Genoa, named *Raggio*, undertook to unroll them; and by a moſt curious, though tedious proceſs, ſo far ſucceeded, as to tranſcribe three Greek Treatiſes on Philoſophy and Muſic; but finding (as I hear) no other encouragment than his ſalary, which was but little more than you pay ſome of your ſervants, the work was unhappily diſcontinued. Were theſe manuſcripts in England, they would not long remain a ſecret to the world."

Watkins's Travels through Switzerland, Italy, &c.

PORTICO, in architecture, a kind of gallery on the ground; or a piazza encompaſſed with arches ſupported by columns, where people walk under covert. The roof is uſually vaulted, ſometimes flat. The ancients called it *lacunar*. Though the word *portico* be derived from *porta*, "gate, door;" yet it is applied to any diſpoſition of columns which form a gallery, without any immediate relation to doors or gates. The moſt celebrated porticoes of antiquity were, thoſe of Solomon's temple, which formed the atrium or court, and encompaſſed the ſanctuary; that of Athens, built for the people to divert themſelves in, and wherein the philoſophers held their diſputes and converſations, (ſee Porch); and that of Pompey at Rome, raiſed merely for magnificence, conſiſting of ſeveral rows of columns ſupporting a platform of vaſt extent; a draught whereof, Serlio gives us in his antique buildings. Among the modern porticoes, the moſt celebrated is the piazza of St Peter of the Vatican.—That of Covent-Garden, London, the work of Inigo Jones, is alſo much admired.

PORTII. See Pompeii.

PORTLAND, a peninſula in Dorſetſhire, of great ſtrength both by nature and art, being ſurrounded with inacceſſible rocks, except at the landing-place, where there is a ſtrong caſtle, called *Portland caſtle*, built by king Henry VIII. There is but one church in the iſland: and that ſtands ſo near the ſea, that it is often in danger from it. It is now chiefly noted for the free-ſtone which is found there, and which is greatly employed in London, and other parts of England, for building the fineſt ſtructures. St Paul's church, in particular, was built therewith. W. Long. 2. 35. N. Lat. 50. 30.

The following cuſtom at Portland is worthy of notice. "While I was looking over the quarries at Portland (ſays Mr Smeaton), and attentively conſidering the operations, obſerving how ſoon the quarrymen would cut half a ton of ſpawls from an unformed block, and what large pieces flew off at every ſtroke; how ſpeedily their blows followed one another, and how inceſſantly they purſued this labour with a tool of from 18 to 20 pound weight; I was naturally led to view and conſider the figure of the operative agent; and after having obſerved, that by far the greateſt number of the quarrymen were of a very robuſt hardy form, in whoſe hands the tool I have mentioned ſeemed a mere play-thing, I at laſt broke out with ſurpriſe, and inquired of my guide, Mr Roper, where they could poſſibly pick up ſuch a ſet of ſtout fellows to handle the *kevel*, which in their hands ſeemed nothing? for I obſerved, that in the ſpace of 15 minutes, they would knock off as much waſte matter from a maſs of ſtone, as any of that occupation I had ever ſeen before would do in an hour. Says Roper, 'we do not go to fetch thoſe men from a diſtance, they are all born upon the iſland, and many of them have never been farther upon the main land than to Weymouth.' I told him, I thought the air of that iſland muſt be very propitious, to furniſh a breed of men ſo particularly formed for the buſineſs they followed. 'The air (he replied), though very ſharp from our elevated ſituation, is certainly very healthy to working men; yet if you knew how theſe men are produced, you would wonder the leſs; for all our marriages here are productive of children.' On deſiring an explanation how this happened, he proceeded: 'Our people here, as they are bred to hard labour, are very early in a condition to marry and provide for a family; they intermarry with one another, very rarely going to the main-land to ſeek a wife; and it has been the cuſtom of the iſland, from time immemorial, that they never marry till the woman is pregnant.' But pray (ſaid I) does not this ſubject you to a great number of baſtards? Have not your Portlanders the ſame kind of fickleneſs

in their attachments that Englishmen are subject to? and, in consequence, does not this produce many inconveniences? 'None at all (replies Roper), for previous to my arrival here, there was but one child on record of the parish register that had been born a bastard in the compass of 150 years. The mode of courtship here is, that a young woman never admits of the serious addresses of a young man, but on supposition of a thorough probation. When she becomes with child, she tells her mother, the mother tells her father, her father tells his father, and he tells his son, that it is then proper time to be married.' But suppose, Mr Roper, she does not prove to be with child, what happens then? Do they live together without marriage? or, if they separate, is not this such an imputation upon her, as to prevent her getting another suitor? 'The case is thus managed (answered my friend), if the woman does not prove with child after a competent time of courtship, they conclude they are not destined by Providence for each other; they therefore separate; and as it is an established maxim, which the Portland women observe with great strictness, never to admit a plurality of lovers at one time, their honour is noway tarnished: she just as soon (after the affair is declared to be broke off) gets another suitor, as if she had been left a widow, or that nothing had ever happened, but that she had remained an immaculate virgin.' But pray, Sir, did nothing particular happen upon your men coming down from London? 'Yes (says he) our men were much struck, and mightily pleased with the facility of the Portland ladies, and it was not long before several of the women proved with child; but the men being called upon to marry them, this part of the lesson they were uninstructed in; and on their refusal, the Portland women arose to stone them out of the island; insomuch, that those few who did not choose to take their sweethearts for *better or for worse*, after so fair a trial, were in reality obliged to decamp; and on this occasion some few bastards were born: but since then matters have gone on according to the ancient custom."

PORTLAND VASE, a celebrated funeral vase which was long in possession of the Baberini family; but which was lately purchased for 1000 guineas by the Duke of Portland, from whom it has derived its present name. Its height is about ten inches, and its diameter where broadest six. There are a variety of figures upon it of most exquisite workmanship, in bas relief of white opake glass, raised on a ground of deep blue glass, which appears black except when held against the light. It appears to have been the work of many years, and there are antiquarians who date its production several centuries before the Christian era; since, as has been said, sculpture was declining in excellence in the time of Alexander the Great.

Respecting the purpose of this vase, and what the figures on it were meant to represent, there have been a variety of conjectures, which it is not our business to enumerate. We think with Dr Darwin* that it was not made for the ashes of any particular person deceased; and therefore that the subject of its embellishments is not a private history, but of a general nature. But we are not sure that he is right in conjecturing it to represent a part of the Eleusinian mysteries; because that conjecture depends on Warburton's explanation of the 6th book of the Æneid, which does not now command that respect which it did when it was first proposed. We shall therefore give a short account of the several figures, without noticing any of the theories or conjectures that have been made about them.

* *Loves of the Plants.*

In one compartment three exquisite figures are placed on a ruined column, the capital of which is fallen, and lies at their feet among other disjointed stones: they sit under a tree on loose piles of stone. The middle figure is a female in a reclining and dying attitude, with an inverted torch in her left hand, the elbow of which supports her as she sinks, while the right hand is raised and thrown over her drooping head. The figure on her right hand is a man, and that on the left a woman, both supporting themselves on their arms, and apparently thinking intensely. Their backs are to the dying figure, and their faces are turned to her, but without an attempt to assist her. On another compartment of the vase is a figure coming through a portal, and going down with great timidity into a darker region, where he is received by a beautiful female, who stretches forth her hand to help him: between her knees is a large and playful serpent. She sits with her feet towards an aged figure, having one foot sunk into the earth, and the other raised on a column, with his chin resting on his hand. Above the female figure is a Cupid preceding the first figure, and beckoning him to advance. This first figure holds a cloke or garment, which he seems anxious to bring with him, but which adheres to the side of the portal through which he has passed. In this compartment there are two trees, one of which bends over the female figure and the other over the aged one. On the bottom of the vase there is another figure on a larger scale than the one we have already mentioned, but not so well finished nor so elevated. This figure points with its finger to its mouth. The dress appears to be curious and cumbersome, and above there is the foliage of a tree. On the head of the figure there is a Phrygian cap: it is not easy to say whether this figure be male or female. On the handles of the vase are represented two aged heads with the ears of a quadruped, and from the middle of the forehead rises a kind of tree without leaves: these figures are in all probability mere ornaments, and have no connection with the rest of the figures, or the story represented on the vase.

PORTLANDIA, in botany: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is elevated and funnel-shaped; the antheræ are longitudinal; the capsule pentagonal, and retuse at top; bilocular, and crowned with a pentaphyllous calyx.

There are two species, viz. the grandiflora and hexandra; the former of which has been particularly described by Dr Browne, who has also given a good figure of it. It has frequently flowered in the royal garden at Kew, and in Dr Pitcairn's at Islington.

The external bark is remarkably rough, furrowed, and thick; it has no taste. The inner bark is very thin, and of a dark brown colour. Its taste is bitter and astringent, and its virtues are the same as those of the Jesuit's bark. Infused in spirits or wine with a little orange-peel, it makes an excellent stomachic tincture.

PORT-LOUIS, is a strong town of France, in Bretagne,

tagne, in the dioceſe of Vannes, with a citadel and a good harbour. It was fortified by Louis XIII. from whom it derived its name. It was a ſtation for part of the royal navy and the Eaſt India ſhips belonging to France. It is ſeated at the mouth of the river Blavet, 27 miles weſt of Vannes. W. Long. 3. 18. N. Lat. 47. 40.

Port-Mahon. See Minorca.

PORTO. See Oporto.

Porto-Be'lo, a town of North America, ſituated in N. Lat. 9. 3. W. Long. 79. 45. cloſe to the ſea, on the declivity of a mountain, which ſurrounds the whole harbour. This harbour is ſo large, deep, and ſafe, that Columbus, who firſt diſcovered it, gave it the name of *Porto-Bello*, or the "Fine Harbour," which is now commonly uſed to denote the town. The number of the houſes is about 130; moſt of them of wood, large and ſpacious, forming one long ſtreet along the ſtrand, with other ſmaller ones croſſing it. The governor of the town is always a gentleman of the army, ſubordinate to the preſident of Panama; but having under him the commandants of the forts that defend the harbour. At the eaſt end of the town, on the road to Panama, is a place called *Guinea*, where all the negroes of both ſexes, whether ſlaves or free, have their habitations. This place is very much crowded when the galleons are here, moſt of the inhabitants of the town quitting their houſes entirely for the ſake of letting them; while others content themſelves with a ſmall part, in order to make money of the reſt. The Mulattoes and other poor families alſo remove either to Guinea, or to cottages already erected near it, or built on the occaſion. Great numbers of artificers likewiſe who flock to Porto-Bello from Panama to work at their reſpective callings during the fair, lodge in Guinea for cheapneſs. Towards the ſea, in a large tract between the town and Gloria caſtle, barracks are erected, in moſt of which the ſhips crews keep ſtalls of ſweetmeats, and other kinds of eatables, brought from Spain; but at the concluſion of the fair, when the ſhips put to ſea, all theſe buildings are taken down, and the town returns to its former tranquillity and emptineſs. In 1739, the harbour was defended by a caſtle and two forts; which were all demoliſhed by admiral Vernon, who, with ſix ſhips only, made himſelf maſter of this port. The country about Porto-Bello is over-run with mountains and impenetrable foreſts, except a few valleys, in which are ſome ſcattered farms. Among the mountains that ſurround the harbour is one diſtinguiſhed by the name of *Capiro*, and by its ſuperior loftineſs is a ſort of barometer to the country, by foretelling every change of weather. Its top is always covered with clouds, of a denſity and darkneſs ſeldom ſeen in thoſe of the atmoſphere. When theſe clouds thicken, increaſe their blackneſs, and ſink below their uſual ſtation, it is a ſure ſign of a tempeſt; while, on the other hand, their clearneſs and aſcent as certainly indicate the approach of fair weather. Theſe changes are very ſudden and frequent here. The ſummit of the mountain is ſcarce ever clear from clouds; and when it happens, it is only, as it were, for an inſtant. Except in the time of the fair, all the inhabitants of Porto-Bello do not amount to 3000; half of whom are Indians, Mulattoes, or Negroes; the Spaniards of any ſubſtance not chooſing to reſide in a place ſo extremely unhealthy, and fatal even to the lives of the natives. Ulloa tells us, that the cattle brought hither from Panama or Carthagena, loſe their fleſh ſo faſt in the beſt paſtures, as to become ſcarce eatable: he aſſures us alſo, that neither horſes nor aſſes are bred here. The heat, indeed, is exceſſive; and the torrents of rain are ſo dreadful, ſudden, and impetuous, that one not accuſtomed to them would imagine a ſecond deluge was coming. Theſe torrents are alſo accompanied with frightful tempeſts of thunder and lightning, the awfulneſs of the ſcene being heightened by the repercuſſions from the mountains, and the ſhrieks and howlings of multitudes of monkeys of all kinds which inhabit the ſurrounding woods.

Freſh water pours down in ſtreams from the mountains, ſome running without the town, and others croſſing it. Theſe waters are very light and digeſtive; qualities which in other countries would be very valuable, but are here pernicious, producing dyſenteries, which the patient ſeldom ſurvives. However, theſe rivulets, formed into reſervoirs, ſerve the purpoſes of bathing, which is here found to be very conducive to health.

As the foreſts almoſt border on the houſes of the ſtreets, tygers often make incurſions into the ſtreets during the night, carrying off fowls, dogs, and other domeſtic animals, and ſometimes even children have fallen a prey to them. Beſides the ſnares uſually laid for them, the Negroes and Mulattoes, who fell wood in the foreſts of the mountains, are very dexterous in encountering them; and ſome, for a ſlender reward, even ſeek them in their retreats.

The town of Porto-Bello, which is thinly inhabited by reaſon of its noxious air, the ſcarcity of proviſions, and the barrenneſs of the ſoil, becomes, after the arrival of the galleons, one of the moſt populous towns in the world. He who had ſeen it quite empty, and every place wearing a melancholy aſpect, would be filled with aſtoniſhment to ſee the buſtling multitudes in the time of the fair, when every houſe is crowded, the ſquares and ſtreets encumbered with bales of merchandiſe and cheſts of gold and ſilver, the harbour full of ſhips and veſſels, ſome loaded with proviſions from Carthagena, and others with the goods of Peru, as cocoa, Jeſuit's bark, Vicuna wool, and bezoar ſtones; and this town, at all other times deteſted for its deleterious qualities, becomes the ſtaple of the riches of the Old and New World, and the ſcene of one of the moſt conſiderable branches of trade in the univerſe. Formerly the fair was limited to no particular time; but as a long ſtay in ſuch a ſickly place extremely affected the health of the traders, his Catholic majeſty tranſmitted an order that the fair ſhould not laſt above 40 days; and that, if in that time the merchants could not agree on their rates, thoſe of Spain ſhould be allowed to carry their goods up the country to Peru: and accordingly, the commodore of the galleons has orders to re-embark them, and return to Carthagena; but otherwiſe, by virtue of a compact between the merchants of both kingdoms, and ratified by the king, no Spaniſh trader is to ſend his goods, on his own account, beyond Porto-Bello. The Engliſh were formerly allowed to ſend a ſhip annually to this fair, which turned

Porto, Portrait.

ed to great account; and, whilst the assiento contract subsisted, either with the English or the French, one of their principal factories was at Porto-Bello.

Porto-Farina, a port about 12 miles from Cape Carthage, in the bay of Tunis, where formerly the large vessels belonging to the bey were fitted out, and laid up on their return from a cruize. This harbour is safe from the weather, and opens into a large lake, formed by the Mejerdah, which runs through into the sea.—The north-west wind, which blows right upon the shore, together with the soil brought down by the river, which has the same quality as the Nile of overflowing its banks, has formed a bar, so that only small vessels can now enter. It is still the arsenal where the naval stores are kept. E. Long. 10. 16. N. Lat. 37. 12.

Porto-Farraio, a handsome town of Italy, in the isle of Elba, with a good citadel. It is very strong, and seated on a long, high, steep point of land, to the west of the bay of the same name, which has two forts. It belongs to the great duke of Tuscany, who always keeps a good garrison there. E. Long. 10. 37. N. Lat. 48. 55.

Porto-Longone, a small but very strong town of Italy, and in the isle of Elba, with a good harbour, and a fortress upon a rock almost inaccessible. The king of Naples has a right to put a garrison therein, though the place belongs to the prince of Piombino. It is seated on the east end of the island, eight miles south-west of Piombino. E. Long. 10. 10. N. Lat. 42. 52.

Porto-Santo, an island of the Atlantic Ocean, on the coast of Africa, and the least of those called the *Madeiras*. It is about 15 miles in circumference, and produces but little corn; however, there are oxen and wild hogs, and a vast number of rabbits. There are trees which produce the gum or resin called *dragon's blood*; and there is likewise a little honey and wax, which are extremely good. It has no harbour, but good mooring in the road. It belongs to the Portuguese, and is 300 miles west of the coast of Africa. W. Long. 16. 20. N. Lat. 32. 58.

Porto-Seguro, a government of South America, on the eastern coast of Brasil; bounded on the north by the government of Rio-dos-Hilios, on the east by the North Sea, on the south by the government of Spiritu-Santo, and on the west by the Tupicks. It is a very fertile country, and the capital town is of the same name. It is built on the top of a rock, at the mouth of a river, on the coast of the North Sea, and is inhabited by Portuguese. W. Long. 38. 50. S. Lat. 17. 0.

Porto-Vecchio, is a sea-port town of Corsica, in the Mediterranean Sea, seated on a bay on the eastern coast of the island. It is 12 miles from Bonifacio, and 40 north of Sardinia. E. Long. 9. 20. N. Lat. 41. 42.

Porto-Venereo, is a town of Italy, on the coast of Genoa, at the entrance of the gulph of Spetia. It is seated on the side of a hill, at the top of which there is a fort. It has a very good harbour, and is 45 miles south-east of Genoa. E. Long. 9. 38. N. Lat. 44. 5.

PORTRAIT, or PORTRAITURE, in painting, the representation of a person, and especially of a face, done from the life. In this sense we use the term *portrait-painting*, in contradistinction to *history-painting*, where a resemblance of persons is usually disregarded. Portraits, when as large as the life, are usually painted in oil-colours; sometimes they are painted in miniature with water-colours, crayons, pastils, &c. See PAINTING, p. 641.

Portree, Portsmouth.

PORTREE, is a small village, containing a church and a very few houses, with an excellent bay and a good harbour, in the Isle of Sky. "The entrance of the bay (Mr Knox tells us) represents agreeable landscapes on both sides, with excellent pasture.

Knox's Tour.

'The bay of Portree (says Mackenzie), off the houses, is an exceeding good harbour for a few ships of any size; it is well sheltered, the ground good, the depth from five to 14 fathoms, and nothing to fear coming in but a rock, about half a cable's length from Airderachig Point, on the starboard as you enter the anchorage, part of which is always above water.' It is the only port or harbour to a very considerable division of Sky, on the east side. From this opening to the northern extremity, a course of 20 miles, the shore is one continued line of lofty rocks, where no ship can find refuge in the mildest weather, and where inevitable dangers await the mariners in rough weather.

"James V. of Scotland and several of his nobility landed here, when they made the tour of the Hebrides in 1535; from which circumstance, this fine bay has got the honourable name of *Portree*."

Mr Knox tells us, "that the country round this village, though mountainous, is well inhabited; it raises much grain, and many cattle. Here the late Sir James Macdonald had marked out the lines of a town; and government, it is said, promised to assist him in the work with 500 l.; but the death of that gentleman put an end to these promising appearances, and matters remain in *statu quo*."

PORTSMOUTH, a sea-port town in Hampshire, with one of the most secure and capacious harbours in England, being defended by a numerous artillery, both on the sea and land-side, and very good fortifications. A great part of the royal navy is built here; and here are some of the finest docks, yards, and magazines of naval stores, in Europe. It is seated in the isle of Portsey, being surrounded by the sea except on the north side, where there is a river which runs from one arm of it to the other. It is much resorted to on account of the royal navy, whose usual rendezvous is at Spithead, which is at the east end of the isle of Wight, and opposite to Portsmouth. There is a draw-bridge over the river, and it has always a good garrison. It is governed by a mayor, 12 aldermen, and burgesses, and sends two members to parliament. It has one church, and two chapels, one in the garrison, and one in the Common, for the use of the dock, and others, besides several meeting-houses of the dissenters. The houses of Portsmouth amount to about 2000, and the inhabitants to about 12,000. W. Long. 1. 1. N. Lat. 50. 47.

The town is supposed to receive its name from Port, a famous Saxon chieftain, who, A. D. 501. landed here with his two sons. It made a considerable figure in the time of the Saxons; and from the utility of its situation, was highly favoured by all our monarchs of the Norman line. It was incorporated, and became also a parliamentary borough. In the reign of Edward III. it was in a very flourishing state; but, A. D. 1338, in the very same reign, was burned by the French, when

when that monarch, which was afterwards ratified by king Richard II. forgave the inhabitants a debt, and remitted their fee-farm for 10 years; within which ſpace they ſo recovered themſelves, as to equip a ſquadron, which failed into the mouth of the Seine, ſunk two ſhips, and brought away a great booty. The ſingular excellence of its port, and the convenience of fitting out fleets from thence in the time of a French war, induced Edward IV. to think of fortifying it, as he actually, in ſome meaſure, did; which fortifications were farther carried on by Richard III. But king Henry VII. was the firſt who ſettled a garriſon therein; which was increaſed, and the place made ſtill ſtronger, in the reign of Henry VIII. who had a great dock there, wherein was built the Henry Grace de Dieu, which was the largeſt ſhip in the navy of his time. The ſame monarch, remarkably attentive to the ſecurity of all maritime places, built what is now called *South-Sea Caſtle*, for the protection of this.—The improvements made here in the reign of Q. Elizabeth were much ſuperior to all theſe. King Charles II. after his reſtoration, directed great alterations, eſtabliſhed new docks and yards, raiſed ſeveral forts, and fortified them after the modern manner; which works were augmented under his brother's reign. Notwithſtanding this, king William directed likewiſe freſh alterations and additions; and ſucceeding princes, following his example, have, at a large expence, extended theſe fortifications, and taken in a vaſt deal of ground: ſo that it is at preſent, as the importance of the place deſerves, the moſt regular fortreſs in Britain; and, as it cannot be effectually attacked by ſea, may be juſtly eſteemed impregnable.

PORTSMOUTH, the largeſt town in the ſtate of New Hampſhire in North America. It ſtands on the ſouth-eaſt ſide of Piſcataqua river, about two miles from the ſea, and contains about 600 houſes, and 4400 inhabitants. The town is handſomely built, and pleaſantly ſituated. Its public buildings are, a court-houſe, two churches for Congregationaliſts, one for Epiſcopalians, and one other houſe for public worſhip. Its harbour is one of the fineſt on the continent, having a ſufficient depth of water for veſſels of any burthen. It is defended againſt ſtorms by the adjacent land, in ſuch a manner, as that ſhips may ſecurely ride there in any ſeaſon of the year. Beſides, the harbour is ſo well fortified by nature, that very little art will be neceſſary to render it impregnable. Its vicinity to the ſea renders it very convenient for naval trade. A light-houſe, with a ſingle light, ſtands at the entrance of the harbour.

PORTSOY, is a handſome ſea-port town, ſituated on a ſmall promontory running into the ſea, on the ſouth ſide of the Murray Frith, in Scotland, about ſix miles from Cullen, and ſeven weſt from Banff. It ſends out ſeveral fiſhing veſſels, particularly for the Hebride white fiſhery, and exports a conſiderable quantity of grain. A manufacture of ſtocking and ſewing thread is alſo carried on to a conſiderable amount for the London and Nottingham markets. In the neighbourhood is a ſtratum of marble, of a dark greeniſh colour, in which, it is ſaid, the curious ſubſtance called ASBESTOS, or earth-flax, has been found. From the aſbeſtos a ſort of incombuſtible cloth is made, which is purified by throwing it into the fire. W. Long. 2. 5. N. Lat. 57. 50.

PORTUGAL, the moſt weſterly kingdom of Europe, bounded on the weſt and ſouth by the Atlantic Ocean, and on the eaſt and north by Spain; extending about 310 miles in length, and 150 in breadth.

Portugal. See *Map* of Spain and Portugal.

1 Boundaries.

By modern writers, we find this country conſtantly ſtyled in Latin *Luſitania*; and it is certain, that anciently a country of Spain went by that name; but it does not by any means appear that the country called by the ancients *Luſitania* had the ſame boundaries with the modern kingdom of Portugal. Before Auguſtus Cæſar, Luſitania ſeems to have been bounded on the north by the ocean, and on the ſouth by the river Tagus; by which means it comprehended all Galicia, and excluded two of the ſix provinces of Portugal. But in the more ſtrict and reſtrained ſenſe of the word, it was bounded on the north by the Durius, now the Douro, and on the ſouth by the river Anas, now the Guadiana; in which ſenſe it was not quite ſo long as modern Portugal, but conſiderably broader.

2 Etymology of the name.

The commonly received opinion with regard to the etymology of the word *Portugal*, is, that a great number of Gauls landed at Porto, or Oporto, whence it received the name of *Portus Gallorum*, or *the Port of the Gauls*; and in proceſs of time that name gradually extended over the whole country, being ſoftened, or rather ſhortened, into *Portugal*. But the time when this event happened, the reaſon why theſe Gauls came thither, and what became of them afterwards, are all particulars which lie buried in oblivion. It is alleged, however, that, upon an eminence which overlooks the mouth of the river Douro, there ſtood an ancient town called *Cale*, ſtrong and well peopled, but ill ſeated for trade; and this occaſioned the conſtruction of a lower town or hamlet, which was called *Portus Cale*, that is, *the haven of Cale*; and, in proceſs of time, *Portucalia*. At length, becoming ſo conſiderable as to merit an epiſcopal chair, the biſhops ſubſcribed themſelves, as the records of ancient councils teſtify, *Portucalenſes*, and the name of the city was transferred to the dioceſe. It is true, that theſe biſhops afterwards changed their title, and ſubſcribed themſelves *Portuenſes*, that is, *biſhops of Porto*. But the facts juſt mentioned are actually recorded in authentic hiſtories; and as the dioceſe of Portucalia contained in a great meaſure that little country in which the ſovereignty originally began, the name extended itſelf, together with the acquiſitions of the ſovereigns, and has remained to the kingdom, though the dioceſe itſelf has changed its name, and poſſibly on that very account.

3 Originally only a ſmall kingdom.

Portugal, though even yet but a ſmall kingdom, was originally much ſmaller. The Spaniſh and Portugueſe hiſtorians agree, that Don Alonſo, king of Leon and Caſtile, and ſon to Don Ferdinand the Great, beſtowed his daughter Donna Thereſa in marriage upon an illuſtrious ſtranger, Don Henry, and gave him with her the frontier province which he had conquered from the Moors, ſmall indeed in extent, but excellently ſituated, and ſo pleaſant and fertile, that it has ſometimes been ſtyled *Medulla Hiſpanica*, or *the marrow of Spain*. To this territory was added the title of *Count*; but authors are much divided about the time that this ſtranger came into Spain, and who he was. However, the authors of the Univerſal Hiſtory make it pretty evident, that he was a grandſon of Robert the firſt duke of Burgundy. The manner in which

which he obtained the principality above-mentioned is related as follows:

The king, Don Alonſo, apprehenſive that his ſucceſs in taking the city of Toledo would bring upon him the whole force of the Moors, ſent to demand aſſiſtance from Philip I. of France, and the duke of Burgundy, whoſe daughter he had married. His requeſt was granted by both princes; and a numerous body of troops was ſpeedily collected for his ſervice, at whoſe head went Raymond count of Burgundy, Henry younger brother of Hugh duke of Burgundy, Raymond count of Tholouſe, and many others. They arrived at the court of Don Alonſo in the year 1087, where they were received and treated with all poſſible marks of eſteem; and having in the courſe of two or three years given great proofs of their courage and conduct, the king reſolved to beſtow his only daughter named *Urraca*, then a mere child, being at moſt in her ninth year, upon Raymond count of Burgundy, and aſſigned them the province of Galicia for the ſupport of their dignity.

4 Henry of Burgundy the firſt count of Portugal.

About four years after, Don Alonſo being very deſirous to expreſs his gratitude to Henry of Burgundy, gave him in marriage a natural daughter of his, born while he remained in exile at Toledo, whoſe name was *Donna Thereſa;* and upon this marriage, he gave up in full property the country which has been already mentioned.

The new ſovereign, with his conſort, fixed their reſidence in the town of Guimaraez, pleaſantly ſituated on the banks of the river Ave. The remains of an ancient palace belonging to their ſucceſſors are ſtill to be ſeen; and on account of its having been anciently the capital, the king, Don Denis, granted the inhabitants an immunity from taxes, which they ſtill enjoy.

The Portugueſe, now finding themſelves independent, immediately began, like other nations, to attempt the ſubjection of their neighbours. Henry is ſaid to have performed great exploits againſt the Moors; but the accounts of them are ſo indiſtinct, that they cannot be taken notice of here. He died in 1112; and was ſucceeded by his ſon Don Alonſo, then an infant in the third year of his age.

5 Differences with Caſtile.

In his minority, the kingdom was governed by his mother Donna Thereſa, aſſiſted by two able miniſters. During the firſt nine years of their adminiſtration, nothing remarkable happened; but after that period, ſome differences took place between the queen regent (for ſhe had aſſumed the title of queen after her father's death) and Urraca queen of Caſtile. Thereſa inſiſted, that ſome part of Galicia belonged to her in virtue of her father's will; and therefore ſeized on Tuy, an epiſcopal town, and a place of ſome conſequence. Urraca, having aſſembled a numerous army, went in perſon into Galicia; upon which Thereſa was obliged to abandon Tuy, and take ſhelter in one of her own fortreſſes. The conſequences, in all probability, would have been fatal to the new kingdom, had not the archbiſhop of Compoſtella, without whoſe aſſiſtance Urraca could do nothing, demanded leave to retire with his vaſſals. This offended the queen to ſuch a degree, that ſhe threw him into priſon; which act of violence excited ſuch a commotion among her own ſubjects, that the Portugueſe were ſoon delivered from their apprehenſions. Queen Thereſa fell immediately after into a ſimilar error, by throwing into priſon the archbiſhop of Braga, who had not eſpouſed her cauſe ſo warmly as ſhe had expected. The biſhop, however, was quickly delivered by a bull from the pope, who alſo threatened the kingdom with an interdict; and this was the firſt remarkable offence which Thereſa gave her ſubjects.

Soon after this, Queen Urraca died, and all differences were amicably ſettled at an interview between Thereſa and Don Alonſo Raymond, who ſucceeded to the kingdom of Caſtile. But, in 1126, the king of Caſtile being obliged to march with the whole ſtrength of his dominions againſt his father-in-law the king of Navarre and Arragon, Thereſa took the opportunity of again ſeizing upon Tuy; but the king ſoon returning with a ſuperior army, ſhe was again obliged to abandon her conqueſt. But the greateſt misfortune which befel this princeſs, was a quarrel with her own ſon Don Alonſo Enriquez. It does not appear indeed that Thereſa had given him any juſt cauſe of offence; but it is certain that a civil war enſued, in which the queen's forces were totally defeated, and ſhe herſelf made priſoner, in which ſituation ſhe continued during the remainder of her life.

6 Don Alonſo's wars with the Moors and king of Caſtile.

Enriquez having thus attained to the free and full poſſeſſion of his dominions, made ſeveral attempts upon ſome places in Galicia, but without ſucceſs; ſo that he was at laſt conſtrained to make peace with Alonſo king of Caſtile and Leon, who had aſſumed the title of *Emperor of the Spains;* the more eſpecially as his dominions happened to be at that time invaded by the Moors.—The number of infidels was ſo great, that the count of Portugal had little hopes of ſubduing them; but a plague breaking out in the Mooriſh army, they were obliged to retreat; after which he reduced ſeveral places belonging to that nation. But, in the mean time, the emperor Don Alonſo, breaking into the Portugueſe territories, deſtroyed every thing with fire and ſword. The king of Portugal ſurpriſed and cut off a conſiderable part of his army; which, however, did not hinder the emperor from marching directly towards him.—But, at the interceſſion of the pope's legate, all differences were accommodated, and a peace concluded; all places and priſoners taken on both ſides being delivered up.

In the mean time, the progreſs of the Chriſtian arms in Spain being reported to Abu-Ali Texefien, the miramamolin or chief monarch of the Moors in Barbary, he directed Iſmar, or Iſhmael, his lieutenant in Spain, to aſſemble all the forces in the ſouthern provinces, and drive the Chriſtians beyond the Douro. Iſhmael immediately began to prepare for putting theſe orders in execution; and having added a conſiderable body of troops brought from Barbary to thoſe whom he had raiſed in Spain, the whole army was very numerous. He was met by Don Alonſo of Portugal, in the plains of Ourique, on the banks of the river Tayo; and Iſhmael took all poſſible means to prevent the Chriſtians from

7 Victory Ourique.

paſſing that river, becauſe his own cavalry, in which the ſtrength of his army chiefly conſiſted, had thus more room to act. The Portugueſe forces were very inconſiderable in number in compariſon of the Moors; but Iſhmael, being too confident of victory, divided his army into 12 bodies, and diſpoſed them in ſuch a manner as might beſt prevent the flight, not ſuſtain the attack, of the Chriſtians. The conſequence was, that

Portugal. that his army was overthrown with incredible ſlaughter, and a vaſt number of priſoners taken, among whom were 1000 Chriſtians, of the ſect ſtyled *Mozarabians*, whom, at the requeſt of Theotonus, prior of the Holy Croſs, Don Alonſo ſet at liberty with their wives and children, and procured them ſettlements in his own dominions.

8 Don Alonſo aſſumes the title of king. After this ſignal victory, gained in the year 1139, Don Alonſo was proclaimed king by his ſoldiers, and ever after retained that title, renouncing all kind of ſubjection to the crown of Spain. Being very deſirous, however, of bringing down the power of the emperor, he entered into a league with Raymond count of Barcelona and regent of the kingdom of Arragon againſt that prince. In conſequence of this treaty, he entered Galicia with a conſiderable force on one ſide, while Don Raymond did the ſame on the other. Neither of theſe enterpriſes, however, ſucceeded. The Portugueſe monarch met with a ſevere check in his expedition into Galicia, where he received a dangerous wound, and had ſome of the nobility who attended him taken priſoners. At the ſame time he received intelligence that the Moors had invaded his dominions, ſo that he was obliged to retire; which, however, was not done in ſufficient time to prevent the ſtrong fortreſs of Leyria from falling into their hands. This fortreſs they demoliſhed, and put all the garriſon to the ſword; but the king cauſed it to be rebuilt ſtronger than before, and put a more numerous garriſon into it; however, he undertook nothing farther this campaign. The war continued with various ſucceſs till the year 1145, when the king projected an enterpriſe againſt Santaren, a ſtrong city about 12 miles from Liſbon. In this he luckily ſucceeded: and by that means gained a conſiderable track of country, and a ſtrong barrier to his dominions.

After this ſucceſs Don Alonſo cauſed himſelf with much ceremony to be choſen and crowned king of Portugal before an aſſembly of the ſtates, where he alſo ſolemnly renounced all dependence on the crown of Spain, declaring, that if any of his ſucceſſors ſhould condeſcend to pay tribute or to do homage to that crown, he was unworthy of enjoying the kingdom of Portugal.

9 Reduces Liſbon and other cities. The next year the king undertook the recovery of Liſbon out of the hands of the Moors; and concerning this expedition there are ſuch numbers of fables, that it is almoſt impoſſible to come at the truth. What can be gathered from theſe accounts is, that he undertook the ſiege with a ſmall army, and was able to make but little progreſs in it, partly from the ſtrength of the place, and partly from the numerous garriſon by which it was defended. At length, fortunately for Don Alonſo, a fleet of adventurers, French, Engliſh, Germans, and Flemings, that were going to the Holy Land, anchored at the mouth of the river Tagus, whoſe aſſiſtance he demanded, as not altogether foreign to their deſign of making war on the infidels. His requeſt was readily granted; and, with their aſſiſtance, Liſbon was ſpeedily reduced; which conqueſt ſo much raiſed the reputation of this monarch, and brought ſuch numbers to recruit his army, that before the end of the year 1147 he had reduced 12 other conſiderable cities.

10 Has his regal dignity confirmed by the pope. For many years after this, Don Alonſo was ſucceſsful in all his undertakings. He ſettled the internal government of his kingdom, procured a bull from pope Alexander III. confirming his regal dignity, undertook many ſucceſsful expeditions againſt the Moors, and became maſter of four of the ſix provinces which compoſe the preſent kingdom of Portugal. In all his undertakings he was aſſiſted by the counſels of his Queen Matilda, who was a woman of great capacity, and ſufficient for the government of the kingdom in her huſband's abſence. By her he had a numerous offspring, particularly three daughters; the eldeſt of whom, Donña Mafalda or Mathilda, was married to the king of Arragon; the ſecond, Urraca, to Don Ferdinand king of Leon; and the third, Thereſa, to Philip earl of Flanders. 11

11 His unſucceſsful war with Don Ferdinand of Spain. In 1166, however, the king thought proper, from what provocation we know not, to invade the dominions of his ſon-in-law Don Ferdinand; and poſſeſſed himſelf of Limmia and Turon, two cities of Galicia, in which he put ſtrong garriſons. The next year, elated with his ſucceſs, he marched with a numerous army towards Badajos, which he inveſted; on the news of which, Don Ferdinand, who had aſſembled a large army at Ciudad Rodrigo, marched to its relief. Yet before he could come within ſight of it, it had ſurrendered to the king of Portugal; upon which Don Ferdinand came to a reſolution of beſieging his antagoniſt in his newly conquered city; which Don Alonſo perceiving, endeavoured to draw out his forces into the field. Though he was at that time upwards of 70 years of age, he was himſelf on horſeback, and puſhing forwards at the head of his horſe to get out at the gate, he ſtruck his leg againſt one of the bolts with ſuch violence that the bone was ſhattered to pieces. This accident occaſioned ſuch confuſion, that the Portugueſe troops were eaſily beaten, and Don Alonſo was taken priſoner. He was exceedingly mortified by this diſgrace, eſpecially as he had no great reaſon to expect very kind treatment from his ſon-in-law. However, the king of Leon behaved towards him with the greateſt reſpect and affection. He deſired him to lay aſide all thoughts of buſineſs, and attend to his cure; but finding him reſtleſs and impatient, he aſſured him that he expected nothing more than to have things put into the ſame condition as before the war, and that they might live in peace and friendſhip for the future: to which the king of Portugal moſt readily aſſented; but returned to his dominions before his cure was perfected, which was the cauſe of his being lame all the reſt of his life. However, this did not abate his military ardour; for, notwithſtanding this inconvenience, his courage tranſported him into the field whenever he was called by the intereſt of his ſubjects. Towards the end of his reign, an opportunity ſeemed to preſent itſelf of obtaining once for all an entire releaſe from the diſagreeable pretenſions of the king of Leon, who, it ſeems, had inſiſted on the king of Portugal's doing homage for his kingdom. The opportunity which now preſented itſelf was a quarrel between the king of Leon and his nephew Don Alonſo king of Caſtile. The latter aſked aſſiſtance from the king of Portugal, which was readily granted. But Don Ferdinand, having received intelligence that the infant Don Sancho (the king's eldeſt ſon) was advancing towards Ciudad Rodrigo, aſſembled his troops on that frontier with ſuch diligence, 12

12 Don Sancho's ſucceſs againſt the Moors. that he was enabled to attack him unexpectedly, and entirely defeated him. Underſtanding, however, that Don Sancho was recruiting his forces with great diligence, he

Portugal. he let him know that they might be much better employed againſt the infidels, who remained careleſs and unprepared, expecting the iſſue of the war. Don Sancho made a proper uſe of this advice; and, after making ſome motions to amuſe the enemy, made a ſudden irruption into Andaluſia, penetrating as far as Triana, one of the ſuburbs of Seville. The Moors aſſembled their forces in order to attack him on his retreat; but Don Sancho having firſt fatigued them by the celerity of his march, at length choſe a ſtrong camp, and, having given his troops time to repoſe, drew them out and offered the enemy battle. The Moors accepted the challenge, but were entirely defeated; and Don Sancho returned into Portugal with ſpoils to an immenſe amount. For ſome years after the war was continued without any remarkable event; but, in 1184, Joſeph king of Morocco, having already tranſported multitudes of men from Barbary, at length followed in perſon with a prodigious army, and carried all before him as far as the Tayo. He appeared before the city of Santaren; but having wearied and reduced his army by unſucceſsful aſſaults on that place, he was attacked by the Portugueſe forces aſſiſted by Ferdinand of Leon, entirely defeated, and himſelf killed. By this victory, the Portugueſe were left at liberty to improve the interior part of their country, and fortify their frontiers; and during this interval, the king died in the 76th year of his age, in the year 1185.

13 His wife adminiſtration when king.

Don Alonſo was ſucceeded by his ſon Don Sancho I. Of this prince it is remarkable, that, before he aſcended the throne, he was of a reſtleſs and warlike diſpoſition; but no ſooner did he come to the poſſeſſion of the kingdom, than he became a lover of peace, and began with great aſſiduity to repair the cities that had ſuffered moſt by the war, and to repeople the country around them. By his ſteady attention to this, he in a very ſhort time quite altered the appearance of his territories, and procured to himſelf the glorious title of *The reſtorer of cities, and father of his country*. In the year 1189, a fleet, compoſed for the moſt part of Engliſh veſſels, but having on board a great number of adventurers of other nations bound to the Holy Land, entered the river of Liſbon. They were very kindly received, and ſupplied with all kinds of refreſhments by Don Sancho, who took this opportunity of ſoliciting them to aſſiſt him in a deſign he had formed of attacking the city of Silves in Algarve; to which they readily yielded. Having joined a ſquadron of his own galleys, and marched a body of troops by land, the place was reduced, and the Engliſh, according to agreement, rewarded with the plunder. But, in a ſhort time, the Moors from Africa having again invaded Portugal, the town was ſeveral times taken and retaken, till at laſt Don Sancho, being ſenſible of the difficulties that would attend the keeping of it, cauſed it to be demoliſhed. His laſt enterpriſe was the reduction of Elvas; ſoon after which he died with the reputation of the beſt economiſt that ever ſat on the throne of Portugal. With the character of being rather liberal than avaricious, he had amaſſed a treaſure of more than 700,000 crowns in ready money, beſides 1400 merks of ſilver and 100 of gold plate, which he diſpoſed of ſome time before his death. He was interred by his own command with much leſs pomp than his father, in the cathedral of Coimbra; and when his body was taken up 400 years after by order of the king Don Emanuel that it might be laid in a new tomb, it was found uncorrupted. Portugal.

14 Difference with Caſtile.

The hiſtory of Portugal affords ſcarce any event of importance till the year 1289; when, in the reign of Don Denis, a difference commenced with Caſtile, which ſubſiſted for a long time. Frequent reconciliation took place; but theſe were either of very ſhort duration, or never ſincere. At length, in the reign of John I. Don Juan of Caſtile, who had alſo pretenſions to the crown of Portugal, invaded that kingdom at the head of the whole force of his dominions, and with the flower of the Caſtilian nobility entered the province of Alentego. According to the Portugueſe hiſtorians, he beſieged the city of Elvas without effect; which diſappointment enraged him to ſuch a degree, that he determined next year to invade Portugal a ſecond time, and ruin all the country before him. Accordingly, having collected an army of 30,000 men, he invaded Portugal, took and ruined ſeveral places, while King John lay inactive, with a ſmall army, waiting for ſome Engliſh ſuccours which he expected. At laſt he ventured an engagement with the forces which he had; and, notwithſtanding the great ſuperiority of the enemy, obtained a complete victory; after which he made an irruption into Caſtile, and had the good fortune to gain another battle, which fixed him firmly on the throne of Portugal. The Caſtilians were obliged to conſent to a truce of three years, which was ſoon after improved into a laſting peace.

15 The Caſtilians entirely defeated.

16 The city Ceuta taken from the Moors.

In 1414, King John undertook an expedition againſt the Moors in Barbary, where he commanded in perſon; but before he ſet out, his queen (Philippa the daughter of John duke of Lancaſter) died of grief at the thoughts of his abſence. The expedition, however, proved ſucceſsful, and the city of Ceuta was taken from the Moors almoſt at the firſt aſſault: but ſcarce had the king left that country, when the princes of Barbary formed a league for the recovery of it; and though they were defeated by the young princes of Portugal, whom John again ſent into Barbary, yet the trouble of keeping it was ſo great, that ſome of the king's council were of opinion that the town ſhould be demoliſhed. But John, having conſidered the arguments on both ſides, determined to keep the city; and therefore enlarged and ſtrengthened the fortifications, augmenting his forces there to 6000 foot and 2500 horſe, which he hoped would be ſufficient for keeping off the attacks of the Moors.

King John died in 1428, and was ſucceeded by his eldeſt ſon Edward. He undertook an expedition againſt Tangier in Barbary: but the event proved very unfortunate; the Portugueſe being ſo ſhut up by the Moors, that they were obliged to offer Ceuta back again, in order to obtain leave to return to Portugal. The king's ſon, Don Ferdinand, was left as a hoſtage for the delivery of Ceuta; but was, with the utmoſt cruelty and injuſtice, left in the hands of the infidels, by the king and council of Portugal, who conſtantly refuſed to deliver up the place. Many preparations indeed were made for recovering the prince by force; but before any thing could be accompliſhed the king died in 1430, which put an end to all theſe deſigns. See Pedro (Don).

17 Paſſage to the Eaſt Indies diſcovered.

The war with Barbary continued at intervals, but with little ſucceſs on the part of the Portugueſe; and till

Portugal. till the year 1497, there is no event of any consequence recorded in the history of Portugal. This year was remarkable for the discovery of the passage to the East Indies by the Cape of Good Hope. The enterprising spirit of the Portuguese had prompted them to undertake voyages along the coast of Africa for a considerable time before; but when they undertook their first voyage of discovery, it is probable that they had nothing farther in view than to explore those parts of the coast of Africa which lay nearest to their own country. But a spirit of enterprise, when roused and put in motion, is always progressive; and that of the Portuguese, though slow and timid in its first operations, gradually acquired vigour, and prompted them to advance along the western shore of the African continent, far beyond the utmost boundary of ancient navigation in that direction. Encouraged by success, it became more adventurous, despised dangers which formerly appalled it, and surmounted difficulties which it once deemed insuperable. When the Portuguese found in the torrid zone, which the ancients had pronounced to be uninhabitable, fertile countries, occupied by numerous nations; and perceived that the continent of Africa, instead of extending in breadth towards the west, according to the opinion of Ptolemy, appeared to contract itself, and to bend eastwards, more extensive prospects opened to their view, and inspired them with hopes of reaching India, by continuing to hold the same course which they had so long pursued.

Robertson's India.

After several unsuccessful attempts to accomplish what they had in view, a small squadron sailed from the Tagus, under the command of Vasco de Gama, an officer of rank, whose abilities and courage fitted him to conduct the most difficult and arduous enterprises. From unacquaintance, however, with the proper season and route of navigation in that vast ocean through which he had to steer his course, his voyage was long and dangerous. At length he doubled that promontory, which, for several years, had been the object of terror and of hope to his countrymen. From that, after a prosperous navigation along the south-east of Africa, he arrived at the city of Melinda, and had the satisfaction of discovering there, as well as at other places where he touched, people of a race very different from the rude inhabitants of the western shore of that continent, which alone the Portuguese had hitherto visited. These he found to be so far advanced in civilization and acquaintance with the various arts of life, that they carried on an active commerce, not only with the nations on their own coast, but with remote countries of Asia. Conducted by their pilots, who held a course with which experience had rendered them well acquainted, he sailed across the Indian ocean, and landed at Calecut, on the coast of Malabar, on the 22d of May 1498, ten months and two days after his departure from the port of Lisbon.

18 Circumstances which facilitated the discovery.

19 The king of the country jealous of his new visitors.

The samorin, or monarch of the country, astonished at this unexpected visit of an unknown people, whose aspect, and arms, and manners, bore no resemblance to any of the nations accustomed to frequent his harbours, and who arrived in his dominions by a route hitherto deemed impracticable, received them at first with that fond admiration which is often excited by novelty; but in a short time, from whatever motives, he formed various schemes to cut off Gama and his followers. The Portuguese admiral, however, was not to be over-reached by such politics as his. From every danger to which he was exposed, either by the open attacks or secret machinations of the Indians, he extricated himself with singular prudence and dexterity, and at last sailed from Calecut with his ships, loaded not only with the commodities peculiar to that coast, but with many rich productions of the eastern parts of India. He returned to Portugal in two years after his sailing from the Tagus, but with a great loss of men; for out of 148 persons whom he took out with him, only 55 returned. The king received him with all possible testimonies of respect and kindness; created him count of Videgueira; and not only declared him admiral of the Indies, but made that office hereditary in his family.

20 The Venetians dread the ruin of their commerce.

On the first intelligence of Gama's successful voyage, the Venetians, with the quick-sighted discernment of merchants, foresaw the immediate consequence of it to be the ruin of that lucrative branch of commerce which had contributed so greatly to enrich and aggrandize their country; and they observed this with more poignant concern, as they were apprehensive that they did not possess any effectual means of preventing, or even retarding, its operation.

21 Account of the settlement of the Portuguese in India.

The hopes and fears of both were well-founded. The Portuguese entered upon the new career opened to them with activity and ardour, and made exertions, both commercial and military, far beyond what could have been expected from a kingdom of such inconsiderable extent. All these were directed by an intelligent monarch, capable of forming plans of the greatest magnitude with calm systematic wisdom, and of prosecuting them with unremitting perseverance. The prudence and vigour of his measures, however, would have availed little without proper instruments to carry them into execution. Happily for Portugal, the discerning eye of Emanuel selected a succession of officers to take the supreme command in India, who, by their enterprising valour, military skill, and political sagacity, accompanied with disinterested integrity, public spirit, and love of their country, have a title to be ranked with the persons most eminent for virtue and abilities in any age or nation. Greater things perhaps were atchieved by them than were ever accomplished in so short a time. Within 24 years only after the voyage of Gama, the Portuguese had rendered themselves masters of the city of Malacca, in which the great staple of trade carried on among the inhabitants of all those regions in Asia, which Europeans have distinguished by the general name of the *East Indies*, was then established. This conquest secured to them great influence over the interior commerce of India, while, at the same time, by their settlements at Goa and Diu, they were enabled to engross the trade of the Malabar coast, and to obstruct greatly the long established intercourse of Egypt with India by the Red Sea. In every part of the east they were received with respect; in many they had acquired the absolute command. They carried on trade there without rival or controul; they prescribed to the natives the terms of their mutual intercourse; they often set what price they pleased on the goods which they purchased; and were thus enabled to import from Indostan and the regions beyond it, whatever is useful, rare, or agreeable, in greater abundance, and of more various kinds, than had been known formerly in Europe.

Portugal.

Not satisfied with this ascendant which they had acquired in India, the Portuguese early formed a scheme no less bold than interested, of excluding all other nations from participating of the advantages of commerce with the east; and they accomplished one half of what their ambition had planned.

22
Opposition made by the Venetians.

In consequence of this, the Venetians soon began to feel that decrease of their own Indian trade which they had foreseen and dreaded. In order to prevent the farther progress of this evil, they incited the Soldan of the Mameluks to fit out a fleet in the Red Sea, and to attack those unexpected invaders of a gainful monopoly, of which he and his predecessors had long enjoyed undisturbed possession. The Portuguese, however, encountered his formidable squadron with undaunted courage, entirely defeated it, and remained masters of the Indian ocean. They continued their progress in the east almost without obstruction, until they established there a commercial empire; to which, whether we consider its extent, its opulence, the slender power by which it was formed, or the splendor with which the government of it was conducted, there had hitherto been nothing comparable in the history of nations. Emanuel, who laid the foundation of this stupendous fabric, had the satisfaction to see it almost completed. Every part of Europe was supplied by the Portuguese with the productions of the east; and if we except some inconsiderable quantity of them, which the Venetians still continued to receive by the ancient channels of conveyance, our quarter of the globe had no longer any commercial intercourse with India, and the regions of Asia beyond it, but by the Cape of Good Hope.

In September 1522, King Emanuel died of an epidemical fever, and was succeeded by his son John III. The most remarkable transaction of this prince's reign was the introduction of the inquisition into his dominions. This happened in the year 1525, or, as some say, in 1535. A famine happening to cease in a short time after it was introduced, the priests persuaded the ignorant multitude that it was a blessing from heaven on account of the erecting such an holy tribunal. However, it was not long before the bulk of the nation perceived what kind of a blessing the inquisition was: but their discernment came too late; for by that time the inquisitors had acquired such power, that it became equally dangerous and ineffectual to attempt disclosing any of their mysteries.

23
Inquisition introduced into Portugal.

In the mean time Solyman the Magnificent, the most enlightened monarch of the Ottoman race, observing the power and the opulence of the Portuguese rising, and attributing it to its proper cause, and eager to supplant them, sent orders to the bashaw of Egypt to employ his whole strength against the Christians in the East Indies. The bashaw, in obedience to these orders, sailed out from the Red Sea with a greater naval force than ever the Mohammedans had employed before; having 4000 Janizaries, and 16,000 other land troops on board. Yet, by the courage and conduct of the Portuguese officers and soldiers, all this mighty armament was defeated, and their East India possessions saved from the danger which threatened them. In Africa likewise the king of Fez was baffled before the town of Safi, and fresh quarrels breaking out among the princes gave great relief to the Christians, who had long been obliged to carry on a defensive war, and had more than once been on the very brink of ruin. For a long time indeed their safety had been derived only from the quarrels of the Moors among themselves; for such was the envy and jealousy which reigned among the Portuguese, that they could never unite heartily in opposing the common enemy; and therefore, had their enemies united against them, they must certainly have been cut off. But whenever the cheriffs quarrelled with each other, one party was sure to have recourse to the Portuguese; who, by sending them a small supply, secured quiet to themselves, and had the pleasure of seeing their enemies destroy one another. Yet in the end even this had bad consequences; for, on one hand, it kept up a martial spirit among the Moors, and on the other it made them acquainted with the Portuguese discipline; so that after every short interval of repose they not only found them as much enemies as before, but much more formidable than ever. The consequence of all this was, that King John began to apprehend that the conquest of Barbary was impossible, and therefore to limit his desires to the keeping of those few fortresses which he had already; which, though a necessary and prudent measure, displeased the generality of his subjects.

24
Bad state of affairs in Barbary.

King John exerted himself much in the settlement of Brazil in South America, which he brought into a very good state, caused several strong towns to be erected there, and took all possible methods to encourage the conversion of the natives to Christianity. He also made many regulations for the welfare and happiness of his subjects. The disputes of the nobility about precedency were frequently attended with very disagreeable consequences, which made the king resolve once for all to settle them by established rules; and the rules established by him on this occasion have subsisted ever since, and in a great measure prevent these altercations. He had other great designs in his mind, particularly with regard to the reformation, which he had pushed very far with respect to religious persons of both sexes; but, on a close examination of his affairs, he found his subjects in general to have been so much injured by his leaving their concerns to the inspection of his council, that he was thrown by the grief of it into a kind of apoplexy, from which he never recovered. His death happened in June 1557; and he was succeeded by his son Don Sebastian III. an infant of three years of age.

After the death of King John, the administration remained in the hands of the queen, grandmother to Sebastian, who behaved with great prudence and circumspection. The Moors, however, supposing that under a minority they might be able to dispossess the Christians of such places as they held in Barbary, laid close siege to Masagnan. But the queen-regent sent such speedy succours, and promised such rewards to those who distinguished themselves, that the Moors, though they brought 80,000 men into the field, were obliged to abandon the enterprise. This was at first magnified as a high instance of the queen's capacity and wisdom; but in a short time the natural aversion which the Portuguese had to the government of women, together with the prejudice they had against her country, as being a Castilian, appeared so plainly, and gave her so much uneasiness, that of her own accord she resigned her authority into the hands of cardinal Don Henry the

tugal.

the king's brother. By him Don Alexius de Meneſes was appointed the king's governor, and Gonſales de Gomera with two other prieſts his preceptors. By means of thoſe inſtructors the king's education was totally marred. His governor aſſiduouſly inculcated upon him that the chief virtue of a king was courage; that danger was never to be avoided, but always ſurmounted, let the occaſion be what it would. His other tutors, inſtead of inſtructing him in the true religion, only inſpired him with an abhorrence of profeſſed infidels: the conſequence of all which was, that he became raſh, inconſiderate, and obſtinate; all which qualities conſpired to draw upon him the cataſtrophe which ruined both him and the kingdom.

25 o.te- educa- of the ng king ſtian.

After the king was grown up to man's eſtate, his deſire was to diſtinguiſh himſelf againſt the infidels. He himſelf choſe an expedition to the Eaſt Indies; but the prime miniſter Alcoçova, who did not chooſe to attend his monarch to ſuch a diſtance, ſubſtituted Africa in its ſtead. This expedition the king entered into in the moſt inconſiderate and abſurd manner. He firſt ſent over Don Antonio prior of Crato, with ſome hundreds of ſoldiers; carried his principal courtiers over with him from a hunting match, and without equipages; he then ſent for the duke of Aveyro, with ſuch troops as he could collect on the ſhort warning he had got; and when all theſe were aſſembled, the king ſpent his time in hunting, and ſlight excurſions againſt the enemy, without doing any thing of conſequence, except expoſing his perſon upon all occaſions. At length he returned to Portugal in ſuch tempeſtuous weather, that his ſubjects had given him up for loſt; when they were agreeably ſurpriſed by his unexpected arrival in the river of Liſbon, which they celebrated with the greateſt rejoicings.

26 under- es an ex- i'ion a- nſt A- a.

The little ſucceſs which attended the king in this expedition ſerved only to inflame him more with deſire for another; ſo that from the time he returned, he ſeemed to think on nothing elſe. He was highly delighted alſo with an accident which at this time furniſhed him with a pretence for war, though of that he ſtood in no great need. Muley Hamet, king of Fez and Morocco, had been diſpoſſeſſed of his dominions by his uncle Muley Moloch. At the beginning of this war Don Sebaſtian had offered him his troops in Africa, which offer was rejected with contempt: but now being a fugitive, and having in vain applied for aſſiſtance to Philip of Spain, Muley Hamet applied to the king of Portugal; and, that he might the more eaſily ſucceed, cauſed the fortreſs of Arzila, which his father had recovered, to be reſtored to the Portugueſe. The king was in rapture at this event, and fancied that his glory would exceed that of all his predeceſſors. He was adviſed againſt this expedition, however, by all his friends. King Philip of Spain having done every thing to diſſuade him from it in a perſonal conference, ſent Franciſco Aldana, an old and experienced officer, to Morocco; and at his return ordered him to attend Don Sebaſtian, in order to give him an account of the ſtate of affairs in that country. This he performed with the greateſt fidelity, but without any effect. The queen dowager and cardinal united in their endeavours to divert him from this unfortunate enterpriſe; but he treated them both with ſo little reſpect, that his grandmother broke her heart; and the cardinal, to ſhow his diſtaſte to the meaſure, retired to Evora without coming either to court or council; which example was followed by many of the nobles. Many of theſe, however, ſent very free remonſtrances to the king on the impropriety of his conduct; and King Philip ſent to him the duke de Medina Celi, once more to lay before him the reaſons why he thought his ſcheme impracticable, and to put him in mind that he had no hand in puſhing him upon his deſtruction, or of concealing from him the dangers into which he ſeemed determined to plunge himſelf and his ſubjects. Laſtly, he received a letter on the ſubject from Muley Moloch himſelf, wherein that prince explained to him his own right to the crown of Fez, and ſhowed that he had only diſpoſſeſſed a tyrant and a murderer, who had therefore no right to his friendſhip or aſſiſtance. He next aſſured him that he had no reaſon to fear either the power or neighbourhood of the Portugueſe; as a proof of which, and as a mark of his eſteem, he was content to make him a preſent of ten miles of arable ground round each of the fortreſſes he poſſeſſed in Africa, and which indeed were no more than four, viz. Tangier, Ceuta, Maſagan, and Arzila. At the ſame time he addreſſed himſelf to King Philip of Spain, with whom he was on good terms, deſiring him to interpoſe with his nephew Sebaſtian, that things might be yet adjuſted without the effuſion of human blood. But the king of Portugal was deaf to all ſalutary advice; and therefore paid no regard to this letter, nor to the remonſtrances of his uncle. On the 24th of June 1577, therefore, he ſet ſail from the bar of Liſbon with a fleet of 50 ſhips and five galleys, twelve pieces of cannon, and tranſports and tenders, making up near 1000 ſail. His troops conſiſted of 9000 Portugueſe foot; 3000 Germans; 700 Italians commanded by Sir Thomas Stukeley, an Engliſh exile, but remarkably brave; 2000 Caſtilians and 300 volunteers, commanded by Don Chriſtopher de Tuvara maſter of the horſe, a man of courage, but without either conduct or experience. He touched firſt at Lagos bay in the kingdom of Algarve, where he remained for four days: thence he proceeded to Cadiz; where he was magnificently feaſted for a week by the duke de Medina Sidonia, who took the opportunity once more, by order of Philip, of diſſuading him from proceeding further in perſon. But this exhortation proved as fruitleſs as the reſt; and the king having ſailed with a ſtrong detachment for Tangier, ordered Don Diego de Souza, his commander in chief, to follow with the remaining part of the army.

Portugal.

27 Account of his forces.

The troops landed on the coaſt of Africa without any bad accident, and joined at Arzila. Here the king was met by the cheriff Muley Hamet, on whoſe account he had undertaken the war, who delivered him his ſon Muley, a boy of 12 years of age, as a hoſtage, and brought a reinforcement of 300 Moors. The boy was ſent to Maſagan under a ſtrong guard; but the father remained in the Portugueſe camp. Here it was reſolved in a council of war to reduce the town of Larache, but it was diſputed whether the troops ſhould proceed thither by land or ſea. Don Sebaſtian, who eſpouſed the former opinion, finding himſelf oppoſed by Muley Hamet, gave him ſuch a rude anſwer, that he left his preſence in diſcontent; after which the king's opinion prevailed, and the army began its march on the 29th of July. As they proceeded, the king received a letter

Portugal letter from the duke of Alba, requesting him to attempt nothing beyond the taking of the town of Larache. Along with the letter was sent an helmet which had been worn by Charles V.

28 Movements and disposition of the armies.

On the other hand Muley Moloch, having intelligence of this formidable invasion, took the field, though at that time so ill of a fever that he could not sit on horseback, with 40,000 foot and 60,000 horse. He conducted every thing, notwithstanding his distressed situation, with the greatest prudence. Finding some reason to suspect that part of his army were desirous of going over to his rival, he proclaimed that such as inclined to join their old master were at liberty to do it. This at once put a stop to the defection, and only a very few made use of the liberty which was granted them. Standing in doubt likewise of the fidelity of a body of 3000 horse, he sent them to reconnoitre the enemy, by which act of confidence he secured them. Still, however, he feared that his officers might be corrupted by the Portuguese gold; for which reason he changed the disposition of his army entirely, so that none of his officers commanded the corps to which they had been accustomed; and therefore, having new men to deal with, had none whom they could trust.

Having taken these precautions, he advanced against the Portuguese army with such celerity, that he came in sight of them on the 3d of August. On this Don Sebastian called a council of war; in which many who out of complaisance had given their opinions for this march, were now for returning. They were separated from the enemy by a river, and the Moors were masters of the ford, so that it was impossible to force them immediately in their posts; neither was it practicable for them to wait for a more favourable opportunity, because they had no provisions. The foreign officers, on the contrary, were of opinion that fighting was now become necessary, and a retreat dangerous. This, however, was violently opposed by the cheriff, who saw plainly that they ran a great risk of being defeated and of losing all, while at the same time they were not certain of gaining any thing of consequence though they should be victorious: whereas, if they drew down towards the sea, they might entrench themselves till they were relieved by their fleet; during which interval if Muley Moloch should die, he looked upon it as certain that a great part of the army would desert to him, which would render him master not only of the kingdom, but of the fate of the Christians also. When he found that the king was bent on fighting, he only requested that the engagement might be delayed till 4 o'clock in the afternoon, that, in case of a defeat, they might have some chance of escaping: but even in this he could not prevail; for the king having disposed of every thing for a battle the next day, was impatient to begin the onset as soon as it was light.

In the mean time Muley Moloch was so sensible of the advantages of his situation, that he was inclined to take the whole Portuguese army prisoners; but finding his disease increase, so that he had no hopes of recovery, he came to the resolution to fight, that his antagonist might not avail himself of his death. The disposition of the Christian army was very regular and correct, through the care of some old officers in Don Sebastian's service: the infantry were disposed in three lines; the battalion of volunteers made the vanguard; the Germans commanded by colonel Amberg, and the Italians by Sir Thomas Stuckeley, were on the right; the Castilian battalions on the left; the Portuguese in the centre and rear; the cavalry, consisting of about 1500 men, partly on the right under the command of the duke d'Avegro, to whom the cheriff joined himself with his horse: on the left was the royal standard, with the rest of the cavalry, under the command of the duke of Barcelos eldest son to the duke of Braganza, Don Antonio prior of Crato, and several other persons of great rank. The king took post at first with the volunteers. Muley Moloch disposed also his troops in three lines: the first consisted of the Andalusian Moors, commanded by three officers who had distinguished themselves in the wars of Granada; the second of renegadoes; and the third of the natives of Africa. They moved in a half moon, with 10,000 horse on each wing, and the rest in the rear, with orders to extend themselves in such a manner as to encompass the Christian army. Muley Moloch, though extremely weak, was taken out of his litter, and set on horseback, that he might see how his commands had been obeyed; and being perfectly satisfied with the situation of his troops, he directed the signal of battle to be given. 29 The Portuguese are entirely defeated. The Christians advanced with the greatest resolution; broke the first line of the Moorish infantry, and disordered the second. On this Muley Moloch drew his sword, and would have advanced to encourage his troops, but that his guards prevented him; on which his emotion of mind was so great, that he fell from his horse. One of his guards caught him in his arms, and conveyed him to his litter; where he immediately expired, having only time to lay his finger on his lips by way of enjoining them to conceal his death. But by this time the Moorish cavalry had wheeled quite round, and attacked the Christian army in the rear: upon which the cavalry in the left wing made such a vigorous effort that they broke the Portuguese on the right; and at this time the cheriff, in passing a rivulet, was drowned. In this emergency, the Germans, Italians, and Castilians, did wonders; but the Portuguese, according to their own historians, behaved indifferently. Attacked on all sides, however, they were unable to resist; and the whole army, except about 50 men, were killed or taken prisoners. The fate of the king is variously related. According to some, he had two horses killed under him, and then mounted a third. His bravest officers were killed in his defence; after which the Moors surrounding him, seized his person, stripped him of his sword and arms, and secured him. They immediately began to quarrel about whose prisoner he was; upon which one of the generals rode in among them, crying, "What, you dogs, when God has given you so glorious a victory, would you cut one anothers throats about a prisoner?" at the same time discharging a blow at Sebastian, he brought him to the ground, when the rest of the Moors soon dispatched him. Others affirm, that one Lewis de Brito meeting the king with his standard wrapped round him, Sebastian cried out, "Hold it fast, let us die upon it!" upon which charging the Moors, he was seized, rescued by Brito, who was himself taken with the standard, and carried to Fez. He affirmed, that after he was taken, he saw the king at a distance, and unpursued. Don Lewis de Lima met him afterwards

[Port]ugal.

making towards the river; and this is the laſt account we have of his being ſeen alive.

Muley Hamet, the brother of Muley Moloch, was proclaimed king by the Moors immediately after the battle. Next day, having ordered all the priſoners to be brought before him, the new ſovereign gave orders to ſearch for the body of Don Sebaſtian. The king's valet-de-chambre brought back a body, which he ſaid was that of his maſter, but ſo disfigured with wounds, that it could not well be known; ſo that notwithſtanding the moſt diligent ſearch, this monarch's death could never be properly authenticated. This body, however, was preſerved by Muley Hamet, who delivered it up as the body of Don Sebaſtian to King Philip of Spain. By him it was ſent to Ceuta, from whence it was tranſported to Portugal, and buried among his anceſtors in the monaſtery at Belem, with all poſſible ſolemnity.

By this terrible diſaſter, the kingdom of Portugal, from being the moſt eminent, ſunk at once into the loweſt rank of the European ſtates. All the young nobility were cut off, or carried into ſlavery: the kingdom was exhauſted of men, money, and reputation; ſo that Don Henry, who aſſumed the government after the death of his brother Don Sebaſtian, found himſelf in a very diſagreeable ſituation. The tranſactions of his reign were quite trifling and unimportant; but after his death a great revolution took place. The crown of Portugal was claimed by three different competitors; viz. the prince of Parma, the dutcheſs of Braganza, and Philip of Spain. Whatever might have been the

30
[Port]ugal [conq]uered [by P]hilip [of S]pain.

merits of their reſpective claims, the power of Philip quickly decided the conteſt in his favour. He found his ſchemes facilitated by the treachery of the regents, who took the moſt ſcandalous methods of putting the kingdom into his hands. Under pretence of inſpecting the magazines, they took out ſome of the powder, and mixed the reſt with ſand: they appointed an agent to go to France for ſuccours, from whence they knew that they could not arrive in time; they diſſolved the ſtates as ſoon as they diſcovered that they were bent on maintaining the freedom of the nation; and, under a ſhow of confidence, ſent off to diſtant places ſuch of the nobility as they ſuſpected.

King Philip, finding every thing in his favour, commanded the duke of Alva to invade Portugal, at the head of 20,000 men. The people, perceiving that they were betrayed, exclaimed againſt the governors, and placed on the throne Don Antonio prior of Crato. But his forces being inexperienced, and he himſelf behaving in a very improper manner, he was quickly defeated by the duke of Alva, and forced to fly out of the kingdom, which he effected with great difficulty. On his flight the whole kingdom ſubmitted, together with the garriſons in Barbary, the ſettlements on the weſtern coaſt of Africa, of Brazil, and in the Eaſt Indies. All the Madeiras, however, except the iſle of St Michael, held out for Don Antonio until they were reduced, and the French navy, who came to their aſſiſtance, entirely defeated and deſtroyed.

31
[...]ms [...]ted by [...] to his [...] ſub-[...].

Philip made his entry into Liſbon as ſoon as the kingdom was totally reduced, and endeavoured to conciliate the affections of the people by confirming the terms which he had before offered to the ſtates. Theſe terms were, that he would take a ſolemn oath to maintain the privileges and liberties of the people: that the ſtates ſhould be aſſembled within the realm, and nothing propoſed in any other ſtates that related to Portugal: that the viceroy or chief governor ſhould be a native, unleſs the king ſhould give that charge to one of the royal family: that the houſehold ſhould be kept on the ſame footing: that the poſt of firſt preſident, and of all offices, civil, military, and judicial, ſhould be filled with Portugueſe; all dignities in the church and in the orders of knighthood confined to the ſame; the commerce of Ethiopia, Africa, and the Indies, reſerved alſo to them, and to be carried on only by their merchants and veſſels: that he would remit all impoſts on eccleſiaſtical revenues: that he would make no grant of any city, town, or juriſdiction royal, to any but Portugueſe: that eſtates reſulting from forfeitures ſhould not be united to the domain, but go to the relations of the laſt poſſeſſor, or be given to other Portugueſe for recompenſe of ſervices: that when the king came to Portugal, where he ſhould reſide as much as poſſible, he ſhould not take the houſes of private perſons for his officers lodging, but keep to the cuſtom of Portugal: that wherever his majeſty reſided, he ſhould have an eccleſiaſtic, a treaſurer, a chancellor, two maſters of requeſts, with under officers, all of them Portugueſe, who ſhould diſpatch every thing relating to the kingdom: that Portugal ſhould ever continue a diſtinct kingdom, and its revenue be conſumed within itſelf: that all matters of juſtice ſhould be decided within the realm: that the Portugueſe ſhould be admitted to charges in the houſeholds of the king and queen of Spain: that all duties on the frontiers ſhould be taken away: and, laſtly, that Philip ſhould give 300,000 ducats to redeem priſoners, repair cities, and relieve the miſeries which the plague and other calamities had brought upon the people. All theſe conditions, formerly offered and rejected by the Portugueſe, the king now confirmed: but whereas the duke of Oſſuna, by way of ſecurity for theſe conditions, had promiſed them a law, that if the king did not adhere to them, the ſtates ſhould be freed from their obedience, and might defend their right by the ſword, without incurring the reproach of perjury, or the guilt of treaſon; this he abſolutely refuſed to ratify.

All theſe conceſſions, however, did not anſwer the purpoſe; nay, though Philip was to the laſt degree laviſh of honours and employments, the Portugueſe were ſtill diſſatisfied. This had alſo an effect which was not foreſeen: it weakened the power, and abſorbed the revenues, of the crown; and, by putting it out of the power of any of his ſucceſſors to be liberal in the ſame proportion, it raiſed only a ſhort-lived gratitude in a few, and left a number of malecontents, to which time was continually adding. 32

Cannot conciliate their affections.

Thus Philip, with all his policy, and endeavours to pleaſe, found his new ſubjects ſtill more and more diſguſted with his government, eſpecially when they found their king treating with the utmoſt ſeverity all thoſe who had ſupported Don Antonio. The exiled prince, however, ſtill ſtyled himſelf *king of Portugal*. At firſt he retired to France, and there demanded ſuccours for the recovery of his dominions. Here he found ſo much countenance, that with a fleet of near 60 ſail, and a good body of troops on board, he made an attempt upon the Terceras, where his fleet was beat by the Spaniards; and a great number of priſoners being taken, 33

Is diſturbed by Don Antonio.

Portugal.

ken, all the officers and gentlemen were beheaded, and a great number of meaner people hanged. Don Antonio, notwithſtanding, kept poſſeſſion of ſome places, coined money, and performed many other acts of regal power; but was at length conſtrained to retire, and it was with ſome difficulty that he did ſo, and returned into France. He paſſed from thence into England, where he was well received; and many fitted out privateers to cruiſe againſt the Spaniards under his commiſſion. But after king Philip had ruined the naval power of Portugal as well as Spain, by equipping the armada, Queen Eliſabeth made no difficulty of owning and aſſiſting Don Antonio, and even of ſending Sir John Norris and Sir Francis Drake with a ſtrong fleet and a great army to reſtore him. Upon this occaſion Don Antonio ſent his ſon Don Chriſtopher a hoſtage to Muley Hamet king of Fez and Morocco, who was to lend him 200,000 ducats. But king Philip prevented this by ſurrendering Arzila: and this diſappointment, the unſeaſonable enterpriſe upon Corunna, and the diſputes that aroſe between Norris and Drake, rendered that expedition abortive; ſo that, except carrying the plague into England, it was attended with no conſequences worthy of notice. He remained ſome time after in England: but finding himſelf little regarded, he withdrew once more into France, where he fell into great poverty and diſtreſs; and at length dying in the 64th year of his age, his body was buried in the church of the nuns of Ave Maria, with an inſcription on his tomb, in which he is ſtyled *king*. He left ſeveral children behind him, who, on account of his being a knight of Malta, and having made a vow of virginity at his entrance into the order, were looked upon as illegitimate. He preſerved, even to the day of his death, a great intereſt in Portugal; and had drawn from thence, in the courſe of his life, immenſe ſums of money; which had been ſquandered in many fruitleſs negociations and attempts to diſturb the poſſeſſions of king Philip in almoſt all parts of his dominions, and particularly in the Indies, where the Portugueſe were rather more averſe to the Caſtilian yoke, or at leaſt teſtified their averſion more openly, than in Europe.

34 Impoſtors pretending to be Don Sebaſtian.

But Don Antonio was not the only pretender to the crown of Portugal: for the people, partly through the love of their prince, and partly from their hatred to the Caſtilians, were continually feeding themſelves with the hopes that Don Sebaſtian would appear and deliver them; and in this reſpect ſuch a ſpirit of credulity reigned, that it was ſaid proverbially, they would have taken a negro for Don Sebaſtian. This humour put the ſon of a tiler at Alcobaza, who had led a profligate life, and at length turned hermit, to give himſelf out for that prince; and having with him two companions, one of them ſtyled himſelf *Don Chriſtopher de Tavora*, and the other the *biſhop of Guarda*, they began to collect money, and were in a fair way of creating much diſturbance, if the cardinal arch-duke had not cauſed him to be apprehended; and after leading him ignominiouſly through the ſtreets of Liſbon, he who took the name of *Sebaſtian* was ſent to the galleys for life, and the pretended biſhop was hanged. Not long after, Gonſalo Alvarez, the ſon of a maſon, gave himſelf out for the ſame king; and having promiſed marriage to the daughter of Pedro Alonſo, a rich yeoman, whom he created earl of Torres Novas, he aſſembled a body of about 800 men, and ſome blood was ſpilt before he was apprehended: at length, being clearly proved to be an impoſtor, himſelf and his intended father-in-law were publicly hanged and quartered at Liſbon; which, inſtead of extinguiſhing this humour, farther increaſed it.

35 Account of a remarkable one.

There was, however, a perſon who appeared, about 20 years after the fatal defeat of Sebaſtian, at Venice, who created much more trouble. He aſſumed the name of *Don Sebaſtian*, and gave a very diſtinct account of the manner in which he had paſſed his time from that defeat. He affirmed, that he had preſerved his life and liberty by hiding himſelf amongſt the ſlain: that, after wandering in diſguiſe for ſome time in Africa, he returned with two of his friends into the kingdom of Algarve: that he gave notice of this to the king Don Henry: that finding his life ſought, and being unwilling to diſturb the peace of the kingdom, he returned again among the Moors, and paſſed freely from one place to another in Barbary, in the habit of a penitent: that after this he became a hermit in Sicily; but at length reſolved to go to Rome, and diſcover himſelf to the pope. On the road he was robbed by his domeſtics, and came almoſt naked to Venice, where he was known, and acknowledged by ſome Portugueſe. Complaint being made to the ſenate, he was obliged to retire to Padua. But the governor of that city ordering him alſo to depart, he, not knowing what to do, returned again to Venice; where, at the requeſt of the Spaniſh ambaſſador, who charged him not only with being an impoſtor, but alſo with many black and atrocious crimes, he was ſeized, and thrown into priſon. He underwent 28 examinations before a committee of noble and impartial perſons; in which he not only acquitted himſelf clearly of all the crimes that had been laid to his charge, but entered alſo into ſo minute a detail of the tranſactions that had paſſed between himſelf and the republic, that the commiſſioners were perfectly aſtoniſhed, and ſhowed no diſpoſition to declare him an impoſtor; moved more eſpecially by the firmneſs of his behaviour, his ſingular modeſty, the ſobriety of his life, his exemplary piety, and his admirable patience under his afflictions. The noiſe of this was diffuſed throughout Europe, and the enemies of Spain endeavoured everywhere to give it credit.

The ſtate, however, refuſed to diſcuſs the great point, whether he was or was not an impoſtor, unleſs they were requeſted ſo to do by ſome prince or ſtate in alliance with them. Upon this the prince of Orange ſent Don Chriſtopher, the ſon of the late Don Antonio, to make that demand; and at his requeſt an examination was made with great ſolemnity: but no deciſion followed; only the ſenate ſet him at liberty, and ordered him to depart their dominions in three days. He went therefore, by the advice of his friends, to Padua, but in the diſguiſe of a monk, and from thence to Florence; where he was arreſted by the command of the grand duke, who delivered him to the viceroy of Naples. The count de Lemos, then in poſſeſſion of that dignity, died ſoon after, before whom he was firſt brought; this man aſſerted, he muſt know him to be Don Sebaſtian, ſince he had been twice ſent to him from the king of Spain. He remained priſoner ſeveral years in the caſtle Del Ovo, where he endured incredible hardſhips. At length he was brought out, led with infamy through the ſtreets of

of the city, and declared to be an impoſtor, who aſſumed the name of *Sebaſtian :* at which words, when proclaimed before him, he ſaid gravely, *And ſo I am.* In the ſame proclamation it was affirmed, that he was in truth a Calabrian ; which as ſoon as he heard, he ſaid, *It is falſe.* He was next ſhipped on board a galley as a ſlave; then carried to St Lucar, where he was ſome time confined ; from thence he was transferred to a caſtle in the heart of Caſtile, and never heard of more. Some perſons were executed at Liſbon for their endeavours to raiſe an inſurrection on his behalf : but it was thought ſtrange policy, or rather a ſtrange want of policy, in the Spaniards, to make this affair ſo public without proofs ; and the attempt to ſilence this objection, by affirming him to be a magician, was juſtly looked upon as ridiculous.

36 onſe-ces of panish niſtra-

The adminiſtration of affairs in Portugal, during the reign of Philip, was certainly detrimental to the nation ; and yet it does not appear that this flowed ſo much from any ill intention in that monarch, as from errors in judgment. His prodigious preparations for the invaſion of England impoveriſhed all his European dominions ; but it abſolutely exhauſted Portugal. The pretenſions of Don Antonio, and the hopes of deſpoiling their Indian fleets, expoſed the Portugueſe to the reſentment of the Engliſh ; from which the king having granted away all his domains, wanted power to defend them. Their clamours were not at all the leſs loud for their being in ſome meaſure without cauſe. The king, to pacify them, borrowed money from the nobility upon the cuſtoms, which were the only ſure remedy he had ſtill left ; and this was attended with fatal conſequences. The branches, thus mortgaged, became, and continue to this hour, fixed and hereditary; ſo that the merchant was oppreſſed, and the king received nothing. This expedient failing, a tax of three *per cent.* was impoſed, in the nature of ſhip-money, for the defence of the coaſts and the commerce, which for ſome years was properly applied ; but it then became a part of the ordinary revenue, and went into the king's exchequer without account. This made way for diverting other appropriated branches; as for inſtance, that for the repair of fortifications, the money being ſtrictly levied, and the works ſuffered to decay and tumble down ; and for the maintenance of the conqueſts in Africa, by which the garriſons mouldered away, and the places were loſt. Upon the whole, in the ſpace of 18 years, the nation was viſibly impoveriſhed : and yet the government of Philip was incomparably better than that of his ſucceſſors ; ſo that his death was juſtly regretted ; and the Portugueſe were taught by experience to confeſs, that of bad maſters he was the beſt.

His ſon Philip, the ſecond of Portugal and the third of Spain, ſat 20 years upon the throne before he made a viſit to Portugal, where the people put themſelves to a moſt enormous expence to receive him ; for which they received little more than the compliment, that before his entry into Liſbon, he knew not how great a king he was. He held an aſſembly of the ſtates, in which his ſon was ſworn ſucceſſor. Having done all that he wanted for himſelf, he acquired a falſe idea of the riches of the nation from an immoderate and fooliſh diſplay of them during his ſhort ſtay at Liſbon ; and having ſhown himſelf little, and done leſs, he returned into Spain ; where he acted the part of a good king upon his death-bed, in deploring bitterly that he never thought of acting it before. The reign of Philip III. and IV. was a ſeries of worſe meaſures, and worſe fortune : all his dominions ſuffered greatly ; Portugal moſt of all. The loſs of Ormus in the Eaſt, of Brazil in the Weſt Indies, together with the ſhipwreck of a fleet ſent to eſcort that from Goa, brought the nation incredibly low, and encouraged the conde duke to hope they might be entirely cruſhed. Theſe are the heads only of the tranſactions for 40 years : to enter in any degree into the particulars, is, in other words, to point out the breaches made by the Spaniſh miniſters on the conditions granted by king Philip ; which, with reſpect to them, was the original contract, and unalterable conſtitution of Portugal while ſubject to the monarchs of Caſtile ; and which, notwithſtanding, they ſo often and ſo flagrantly violated, that one would have imagined they had ſtudied to provoke the wrath of heaven, and inſult the patience of men, inſtead of availing themſelves, as they might have done, of the riches, power, and martial ſpirit of the Portugueſe people.

37 Great loſſes in Aſia and America.

38 The Portugueſe oppreſſed by the Spaniards.

It was the very baſis and foundation of their privileges, that the kingdom ſhould remain ſeparate and independent, and conſequently that Liſbon ſhould continue as much its capital as ever, the ſeveral ſupreme councils and courts reſiding ; ſo that the natives of this realm might not be obliged to travel in ſearch of juſtice. So little, or at leaſt ſo ſhort a time, was this obſerved, that neither promotion nor juſtice was to be obtained without journeys, and Madrid was not more the capital of Caſtile than of Portugal. The general aſſembly of eſtates was to be held frequently, and they were held thrice in the ſpace of 60 years ; and of theſe twice within the firſt three. The king was to reſide in this realm, as often and as long as poſſible ; in compliance with which, Philip I. was there but once, Philip II. but four months, and Philip III. was never there at all. The houſehold eſtabliſhment was ſuppreſſed through all their reigns. The viceroy was to be a native of Portugal, or a prince or princeſs of the blood ; yet when any of the royal family bore the title, the power was in reality in the hands of a Spaniard. Thus, when the princeſs of Mantua was vice-queen, the marquis de la Puebla was to aſſiſt in council, and in all diſpatches ; and ſhe was to do nothing without his advice. The council of Portugal, which was to be compoſed entirely of natives, was filled with Caſtilians, as the garriſons alſo were, though the contrary had been promiſed. The preſidents of provinces, or corregidors, were to be natives ; but by keeping thoſe offices in his own hands, the king eluded this article. No city, town, or diſtrict, were to be given but to Portugueſe ; yet the duke of Lerma had Beja, Serpa, and other parts of the demeſnes of the crown, which were formerly appendages of the princes of the blood. None but natives were capable of offices of juſtice, in the revenue, in the fleet, or of any poſt civil or military ; yet theſe were given promiſcuouſly to foreigners, or ſold to the higheſt bidder ; not excepting the governments of caſtles, cities, and provinces. The natives were ſo far from having an equal chance in ſuch caſes, that no poſts in the preſidials were ever given to them, and ſcarce any in garriſons ; and whenever it happened, in the caſe of a perſon of extraordinary merit, whoſe pretenſions could not be rejected, he was either removed, or not allowed to exerciſe his charge ;

as fell out to the marquis of Marialva and others. The forms of proceeding, the jurisdiction, the ministers, the secretaries, were all changed, in the council of Portugal; being reduced from five to three, then two, and at last to a single person.

39
A revolution in favour of the duke of Braganza.

By reason of these and many other grievances too tedious to be mentioned here, the detestation of the Spanish government became universal; and in 1640 a revolution took place, in which John duke of Braganza was declared king, by the title of John IV. This revolution, as being determined by the almost unanimous voice of the nation, was attended with very little effusion of blood; neither were all the efforts of the king of Spain able to regain his authority. Several attempts indeed were made for this purpose. The first battle was fought in the year 1644, between a Portuguese army of 6000 foot and 1100 horse, and a Spanish army of nearly the same number. The latter were entirely defeated; which contributed greatly to establish the affairs of Portugal on a firm basis. The king carried on a defensive war during the remainder of his life; but after his death, which happened in 1655, the war was renewed with great vigour.

40
Perilous state of Portugal on his death.

This was what the Spaniards did not expect; for they expressed a very indecent kind of joy at his death, hoping that it would be followed by a dissolution of the government. It is not indeed easy to conceive a kingdom left in more perilous circumstances than Portugal was at this time:—The king Don Alonzo Enriquez, a child not more than 13 years of age, reputed of no very sound constitution either in body or mind; the regency in a woman, and that woman a Castilian; the nation involved in a war, and this respecting the title to the crown; the nobility, some of them secretly disaffected to the reigning family, and almost all of them embarked in feuds and contentions with each other; so that the queen scarce knew who to trust or how she should be obeyed. She acted, however, with great vigour and prudence. By marrying her only daughter the princess Catharine to Charles II. King of Great Britain, she procured to Portugal the protection of the English fleets, with reinforcements of some thousands of horse and foot; and at last, in 1665, terminated the war by the glorious victory of Montesclaros. This decisive action broke the power of the Spaniards, and fixed the fate of the kingdom, though not of the king, of Portugal. Alonzo was a prince whose education had been neglected in his youth, who was devoted to vulgar amusements and mean company, and whom the queen for these reasons wished to deprive of the crown, that she might place it on the head of his younger brother Don Pedro. To accomplish this purpose, she attempted every method of stern authority and secret artifice; but she attempted them all in vain. The Portuguese would not consent to set aside the rights of primogeniture, and involve the kingdom in all the miseries attending a disputed succession. After the death, however, of the queen-mother, the infant entered into cabals against the king of a much more dangerous nature than any that she had carried on.

41
Don Alonzo obliged to resign the throne.

Alonzo had married the princess of Nemours; but being, as was said, impotent, and likewise less handsome than his brother, that lady transferred her affection to Don Pedro, to whom she lent her assistance to hurl the king from the throne. Alonzo was compelled to sign a resignation of the kingdom; and his brother, after governing a few months without any legal authority, was in a meeting of the states unanimously proclaimed regent, and vested with all the powers of royalty. Soon after this revolution, for such it may be called, the marriage of the king and queen was declared null by the chapter of Lisbon; and the regent, by a papal dispensation, and with the consent of the states, immediately espoused the lady who had been wife to his brother. He governed, under the appellation of *regent*, 15 years, when, upon the death of the king, he mounted the throne by the title of Don Pedro II. and after a long reign, during which he conducted the affairs of the kingdom with great prudence and vigour, he died on the 9th of December 1706.

42
Don Jo[hn] V. a w[ise] and res[o]lute pri[nce].

Don John V. succeeded his father; and though he was then little more than 17 years of age, he acted with such wisdom and resolution, adhered so steadily to the grand alliance formed against France and Spain, and showed such resources in his own mind, that though he suffered great losses during the war, he obtained such terms of peace at Utrecht, that Portugal was in all respects a gainer by the treaty. The two crowns of Spain and Portugal were not, however, reconciled thoroughly till the year 1737; and from this period they became every day more united, which gave much satisfaction to some courts, and no umbrage to any. In this situation of things, a treaty was made in 1750 with the court of Madrid, by which Nova Colonia, on the river of Plata, was yielded to his Catholic majesty, to the great regret of the Portuguese, as well on account of the value of that settlement, as because they apprehended their possession of the Brasils would by this action be rendered precarious. On the last of July the same year, this monarch, worn out by infirmities, deceased, in the 61st year of his age, and in the 44th of his reign.

43
Don Jo[seph's] e[x]cellent ministr[a]tion.

Don Joseph, prince of Brasil, succeeded him, to the universal satisfaction of his subjects, and with as great expectations as ever any monarch that mounted the throne. It was generally believed that he would make considerable alterations, in which he did not disappoint the hopes of the public; and yet they were done so slowly, with such moderation, and with so many circumstances of prudence, as hindered all grounds of complaint. Amongst other new regulations, the power of the inquisition suffered some restriction; the king directing, that none of their sentences should be put in execution till reviewed and approved by his privy-council. But as in the reign of his father he had consented to the treaty with Spain, he ratified it after his accession, and since carried it into execution upon this noble principle, that no considerations of interest ought ever to induce a monarch to break his word.

44
Dreadf[ul] calamit[ies] during [his] reign.

However, within the space of the few years of this king's reign, the calamities of Portugal in general, and those of the city of Lisbon in particular, cannot, in a great degree, be paralleled in all history. An earthquake, a fire, a famine, an assassination-plot against their prince, executions upon executions, the scaffolds and wheels for torture reeking with the noblest blood; imprisonment after imprisonment of the greatest and most distinguished personages; the expulsion of a chief order of ecclesiastics; the invasion of their kingdom by a powerful, stronger, and exasperated nation; the nume-

rous troops of the enemy laying waſte their territory, bringing fire and ſword with them, and rolling like diſtant thunder towards the gates of their capital; their prince ready almoſt to ſave himſelf by flight! The Spaniſh miniſtry had already decreed the doom of Portugal, and nothing was to be heard at the Eſcurial but *Delenda eſt Carthago*. Carthaginian, perhaps, or Jewiſh ſtory, may poſſibly afford a ſcene ſomething like this, but for the ſhortneſs of the period not ſo big with events, though in their final deſtruction ſuperior. From that indeed, under the hand of Providence, the national humanity and generoſity of Great Britain has preſerved the Portugueſe; and it remains now to be ſeen, in future treaties, how that people will expreſs their gratitude (ſee BRITAIN, n° 450). Thoſe who are able to
45 ſearch deeper into human affairs, may aſſign the cauſes of ſuch a wonderful chain of events; but no wiſe man will aſcribe all this to ſo ſingular a cauſe as that which a Spaniard has done, in a famous pamphlet, printed in the year 1762 at Madrid. It is intitled, *A Spaniſh Prophecy;* and endeavours to ſhow, that all theſe calamities have befallen the Portugueſe, ſolely on account of their connection with the heretic Engliſh. The great Ruler and Governor of the world undoubtedly acts by univerſal laws, regarding the whole ſyſtem, and cannot, without blaſphemy, be conſidered in the light of a partizan. The reſt of the pamphlet tends to ſhow, that his Catholic majeſty carried his arms into Portugal, ſolely to give them liberty, and ſet them free from Engliſh tyranny.

Joſeph dying without male iſſue, the ſucceſſion devolved to Mary, his daughter, now queen of Portugal. She was married ſome time before he died, with the pope's diſpenſation, to his brother Don Pedro.

46 The air of Portugal, in the ſouthern provinces, would be exceſſively hot, if it were not refreſhed by the ſea-breezes; but in the northern, it is much cooler, and the weather more ſubject to rains. The ſpring is extremely delightful here; and the air, in general, more temperate than in Spain. Liſbon has been much reſorted to of late by valetudinarians and conſumptive perſons from Great Britain, on account of its air. The ſoil is very fruitful in wine, oil, lemons, oranges, pomegranates, figs, raiſins, almonds, cheſnuts, and other fine fruits; but there is a want of corn, owing, it is ſaid, in a great meaſure to the neglect of agriculture. There is plenty of excellent honey here; and alſo of ſea and river fiſh, and ſea-ſalt. The horſes in Portugal are briſk lively animals, as they are in Spain, but of a ſlight make: but mules being ſurer-footed, are more uſed for carriage and draught. By reaſon of the ſcarcity of paſture, there are not many herds of cattle or flocks of ſheep; and what they have are ſmall and lean, though the fleſh is tolerably good: their beſt meat is ſaid to be that of hogs and kids. The country in many parts is mountainous: but the mountains contain all kinds of ores; particularly of ſilver, copper, tin, and iron, with a variety of gems, beautifully variegated marble, mill-ſtones, and many curious foſſils. Not far from Liſbon is a mine of ſaltpetre; but none of the metal mines are here worked, the inhabitants being ſupplied with metals of all kinds from their foreign ſettlements. The principal rivers are the Minho, in Latin *Minius;* the Limia, anciently the famed Lethe; the Cavado; the Douro; the Guadiana, anciently Anas; and the Tajo, or Tagus, which is the largeſt river in the kingdom, carrying ſome gold in its ſands, and falling into the ſea a little below Liſbon. There are ſeveral mineral ſprings in the kingdom, both hot and cold, which are much frequented.

47 Religion. The only religion tolerated in Portugal is that of the church of Rome; yet there are many concealed Jews, and thoſe too even among the nobility, biſhops, prebends, monks, and nuns, and the very inquiſitors themſelves. If a Jew pretends to be a Chriſtian and a Roman Catholic, while he is really a Jew, by going to maſs, confeſſion, &c. or if after being converted, or pretending to be converted and pardoned, he relapſes into Judaiſm and is diſcovered, the inquiſition lays hold of him. In the firſt caſe, if he renounce Judaiſm, he is only condemned to ſome corporal puniſhment or public ſhame, and then ordered to be inſtructed in the Chriſtian religion. In the ſecond, he is condemned to the flames without mercy. Beſides Jews and heretics, who broach or maintain any doctrines contrary to the religion of the country, the inquiſition puniſhes all ſodomites, pretenders to ſorcery and the black art, apoſtates, blaſphemers, perjured perſons, impoſtors, and hypocrites. The burning of thoſe condemned by the inquiſition, is called an *auto da fe*, or "act of faith." There are ſeveral tribunals of the inquiſition, one of which is at Goa in the Eaſt Indies; but there are none in Braſil. The number of convents in Portugal is ſaid to be 900. The order of Jeſuits hath been ſuppreſſed in this country, as they have been in others. Here is a patriarch, ſeveral archbiſhops and biſhops: the patriarch is always a cardinal, and of the royal family. The archbiſhops rank with marquiſſes, and the biſhops with counts. The Portugueſe have archbiſhops and biſhops in the other quarters of the world as well as in Europe. The ſums raiſed by the popes here, by virtue of their prerogatives, are thought to exceed the revenues of the crown, and the nuncios never fail of acquiring vaſt fortunes in a ſhort time. Though there are two univerſities and ſeveral academies, yet while the papal power, and that of the eccleſiaſtics, continues at ſuch a height, true learning is like to make but a ſmall progreſs. The language of the Portugueſe does not differ much from that of Spain: Latin is the groundwork of both; but the former is more remote from it, and harſher to the ear, than the latter. The Portugueſe tongue is ſpoken on all the coaſt of Africa and Aſia as far as China, but mixed with the languages of the ſeveral nations in thoſe diſtant regions.

48 Manufactures. With regard to manufactures, there are very few in Portugal, and thoſe chiefly coarſe ſilks, woollen cloths, and ſome linen; but their foreign trade is very conſiderable, eſpecially with England, which takes a great deal of their wine, ſalt, foreign commodities, and fruits, in return for its woollen manufactures, with which the Portugueſe furniſh their colonies and ſubjects in Aſia, Africa, and America. Their plantations in Braſil are very valuable, yielding gold, diamonds, indigo, copper, tobacco, ſugar, ginger, cotton, hides, gums, drugs, dying woods, &c. From their plantations in Africa, they bring gold and ivory, and ſlaves to cultivate their ſugar and tobacco plantations in Braſil. They have ſtill ſeveral ſettlements in the Eaſt Indies, but far leſs conſiderable than formerly. The Azores or Weſtern Iſles, Madeira, and the Cape de Verde iſlands, alſo belong to them;

Portugal.

them; but a great part of the riches and merchandize brought from theſe diſtant countries becomes the property of foreigners, for the goods they furniſh the Portugueſe with to carry thither. The king's fifth of the gold brought from Braſil amounts commonly to about 300,000 l. Sterling; ſo that the whole annual produce of gold in Braſil may be eſtimated at near 2,000,000 Sterling. Liſbon is the greateſt port in Europe next to London and Amſterdam.

49 Conſtitution and government.

As to the conſtitution of Portugal, it is an abſolute hereditary monarchy. Both here and in Spain there were anciently cortes, ſtates, or parliaments; but they have long ſince entirely loſt their ſhare in the legiſlature. For the adminiſtration of the civil government, there is a council of ſtate, and ſeveral ſecretaries; for military affairs, a council of war; for the finances, a treaſury-court; and for the diſtribution of juſtice ſeveral high tribunals, with others ſubordinate to them, in the ſeveral diſtricts into which the kingdom is divided. The cities have their particular magiſtracy. The proceedings of the courts are regulated by the Roman law, the royal edicts, the canon law, and the pope's mandates. Like the Spaniards, they tranſact moſt of their buſineſs in the mornings and evenings, and ſleep at noon. The nobility are very numerous, and many of them are deſcended from natural ſons of the royal family. They are divided into high and low. The high conſiſts of the dukes, marquiſſes, counts, viſcounts, and barons, who are alſo grandees, but of different claſſes, being ſuffered to be covered in the king's preſence, and having the title of *Dons*, with a penſion from the royal treaſury, to enable them the better to ſupport their dignity: the king ſtyles them *Illuſtrious* in his letters, and treats them as princes. A duke's ſons are alſo grandees, and his daughters rank as marchioneſſes. The inferior nobility or gentry are termed *Hidalgos*, i. e. gentlemen: they cannot aſſume the title of *Don* without the king's licence.

50 Revenues of the king.

The revenues of the crown, ſince the diſcovery of the Braſil mines, are very conſiderable; but the real amount can only be gueſſed at. Some have ſaid that it amounts, clear of all ſalaries and penſions, to upwards of 3,000,000 Sterling; others make it a great deal leſs. Thus much is certain, that the cuſtoms and other taxes run exceſſively high. Beſides the royal demeſnes, the hereditary eſtates of the houſe of Braganza, the monopoly of Braſil ſnuff, the coinage, the money ariſing from the ſale of indulgencies granted by the pope, the fifth of the gold brought from Braſil, the farm of the Braſil diamonds, the maſterſhips of the orders of knighthood, and other ſources, yield very large ſums. The forces, notwithſtanding, of this nation, both by ſea and land, are very inconſiderable; their land-forces being the worſt militia in Europe, and their navy of little importance. They would be an eaſy conqueſt to the Spaniards if they were not under the protection of Britain.

51 Orders of knighthood.

There are ſeveral orders of knighthood here, *viz.* the order of Chriſt, the badge of which is a red croſs within a white one, and the number of the commanderies 454. 2. The order of St James, the badge of which is a red ſword in the ſhape of a croſs. A great number of towns and commanderies belong to this order. 3. The order of Aviz, whoſe badge is a green croſs in form of a lily, and the number of its commanderies 49. Though theſe three orders are religious, yet the knights are at liberty to marry. 4. The order of St John, which has alſo ſeveral commanderies.

The king's titles are, *King of Portugal and the Algarves, on this ſide and the other ſide the ſea of Africa; Lord of Guinea, and of the navigation, conqueſts, and commerce, in Ethiopia, Arabia, Perſia, India,* &c. The king's eldeſt ſon is ſtyled *Prince of Braſil*. In the year 1749, pope Benedict XIV. dignified the king with the title of *His moſt faithful majeſty*.

52 Character of the people.

The Portugueſe are repreſented as inferior to the Spaniards both in perſon and genius: as extremely haughty, treacherous, and crafty in their dealings; much given to avarice and uſury; and vindictive, malicious, and cruel. The meaner ſort are ſaid to be extremely addicted to thieving: notwithſtanding, it muſt be owned, that they have ſhown themſelves on many occaſions a brave and warlike people. They are juſtly famed for their ſkill in navigation; and for the many diſcoveries they have made, both in the Eaſt and Weſt Indies. The women here, and in other countries of the ſame degree of heat, are not ſo prolific as in the colder climates; but they are ſaid to be very beautiful whilſt young, though their complexion is ſomewhat upon the olive. Their eyes are very black and ſparkling, and retain their brilliancy after all their other charms are gone. It is the faſhion here, at preſent, as in moſt other countries, for the ladies to ſpoil and disfigure their ſkins and complexions with paints and waſhes: but, though lively and witty, they are ſaid to have a nice ſenſe of female honour. Both men and women make great uſe of ſpectacles; often not ſo much to aid their ſight, as to denote their wiſdom and gravity. Their dreſs, like that of the Spaniards, never uſed to vary, eſpecially among the men; but of late years, both men and women have given much into the French modes. The women, when they go abroad on foot, are wont to uſe long veils, which cover their heads, but leave their faces bare.

Portugallica.

PORTUGALLICA TERRA, earth of Portugal; the name of a fine aſtringent bole, dug in great plenty in the northern part of Portugal.

PORTULACA, PURSLANE: A genus of the monogynia order, belonging to the dodecandria claſs of plants; and in the natural method ranking under the 13th order, *Succulentæ*. The corolla is pentapetalous; the calyx bifid; the capſule unilocular, and cut round. There are ſeveral ſpecies, but the two following are the moſt remarkable. 1. The oleracea, annual, or common culinary purſlane, riſes with herbaceous, low, ſucculent, branchy ſtalks, ſix or eight inches high, garniſhed with wedge-ſhaped, thick, ſucculent leaves, and ſmall cloſe-ſetting flowers. There are two varieties; one with deep green leaves, the other with yellow leaves; both of which riſe from the ſame ſeed. 2. The anacampſeros, perennial, or ſhrubby cape purſlane, riſes with a ſhrubby branchy ſtalk, about ſix inches high, with oval, gibbous, ſucculent leaves, and the ſtalks terminated by ſmall cluſters of red flowers. Both theſe plants are of a ſucculent nature: the firſt is an herbaceous annual, for culinary uſes; and the ſecond a ſhrubby perennial, raiſed by the curious for variety. They are both exotics of a tender quality, of the temperature of greenhouſe or ſtove plants. The common culinary purſlane is raiſed annually from ſeed for ſummer uſe, and is an excellent ingredient

gredient in summer salads, but improper for winter on account of its cold moist nature. The plant being tender, must be raised either on a hot-bed or in a warm border; in which last it will not succeed before April or May. The shrubby sort must be kept in the hot-house, in pots of a dry soil.

PORTUMNA, a town of Ireland, in the county of Galway and province of Connaught, is 74 miles from Dublin. The castle of Portumna, the seat of the Earl of Clanricarde, is at this place, and near it are the ruins of an ancient castle. There is also a garrison for a troop of horse and two companies of foot. The town is seated on the river Shannon, where it falls into Lough Derg. The monks of the Cistertian abbey of Dunbrody, in the county of Wexford, had for a long time a chapel here, dedicated to St Peter and St Paul; but having at length forsaken it, O'Madden, dynast of the country, gave it to the Dominican friars, who, with the approbation of the monks of Dunbrody, erected a friary here and a church, which they dedicated to the blessed Virgin and the original patron saints; at the same time they built a steeple, and all other necessary offices. Pope Martin V. granted a bull to confirm their possessions, dated 8th October 1426; and on the 23d of November following he granted indulgencies to all who had contributed to the building. The walls are still nearly entire, and show that the monastery of Portumna was by no means an ignoble structure. The ancient choir is now the parish-church.

POSE, in heraldry, denotes a lion, horse, or other beast, standing still, with all his four feet on the ground. See Hollingshead's *Description of Britain*, chap. xvi.

POSITIVE, a term of relation opposed to negative. It is also used in opposition to relative or arbitrary: thus we say, Beauty is no positive thing, but depends on the different tastes of people.

Positive Degree, in grammar, is the adjective in its simple signification, without any comparison.

Positive Electricity. In the Franklinian system all bodies supposed to contain more than their natural quantity of electric matter are said to be *positively* electrified; and those from whom some part of their electricity is supposed to be taken away are said to be electrified *negatively*. These two electricities being first produced, one from glass, the other from amber or rosin, the former was called *vitreous*, the other *resinous*, electricity.

POSPOLITE, in the military establishment of Poland, is the name given to a kind of militia. It is the most numerous and the most useless of the Polish armies. It consists of the gentry at large, who, in case of invasion, are assembled by a regular summons from the king, with consent of the diet. Every palatinate is divided into districts, over each of which proper officers are appointed; and every person possessing free and noble tenures is bound to military service, either singly or at the head of a certain number of his retainers, according to the extent and nature of his possessions. The troops thus assembled are obliged only to serve for a limited time, and are not under the necessity of marching beyond the limits of their country. They submit to no discipline but such as they like themselves; and are very apt to mutiny if detained more than a fortnight in the place appointed them to meet in, without marching.

Coxe's Travels.

The mode of levying and maintaining this army is exactly similar to that practised under the feudal system. At present, though it is almost totally unfit for the purposes of repelling a foreign enemy, it is yet a powerful instrument in the hands of domestic faction; for the expedition with which it is raised under the feudal regulations facilitates the formation of those dangerous confederacies which suddenly start up on the contested election of a sovereign, or whenever the nobles are at variance with each other.

POSSE COMITATUS, in law, signifies the power of the county, or the aid and assistance of all the knights, gentlemen, yeomen, labourers, servants, apprentices, &c. and all others within the county that are above the age of 15, except women, ecclesiastical persons, and such as are decrepit and infirm.

This posse comitatus is to be raised where a riot is committed, a possession kept upon a forcible entry, or any force of rescue used contrary to the king's writ, or in opposition to the execution of justice; and it is the duty of all sheriffs to assist justices of the peace in the suppression of riots, &c. and to raise the posse comitatus, or to charge any number of men for that purpose.

POSSESSION, in law, is either actual, where a person actually enters into lands or tenements descended or conveyed to him; or where lands are descended to a person, and he has not yet entered into them. A long possession is much favoured by the law as an argument of right, even though no deed can be shown, and it is more regarded than an ancient deed without possession.

If he that is out of possession of land brings an action, he must prove an undeniable title to it; and when a person would recover any thing of another, it is not sufficient to destroy the title of the person in possession without he can prove that his own right is better than his.

In order to make possession lawful upon an entry, the former possessor and his servants are to be removed from off the premisses entered on: but a person by lease and release is in possession without making any entry upon the lands.

Possession, in Scots law. See Law, Part III. N° clxii. 11, &c.

Dæmoniacal Possession. (See Dæmon and Dæmoniacs.) In the third volume of the Manchester Transactions, there is a paper on *popular illusions* or medical demonology by Dr Ferriar. He informs us in a note, that, on the 13th of June 1788, George Lukins of Yatton in Somersetshire was exorcised in the temple church at Bristol, and delivered from the possession of seven devils by the efforts of seven clergymen. An account of his deliverance was published in several of the public papers, authenticated by the Reverend Mr Easterbrook, vicar of the temple church in Bristol.—Dr Ferriar gives us the following particulars, extracted from this account, which we shall here insert.

"Lukins was first attacked by a kind of epileptic fit, when he was going about acting Christmas plays, or mummeries: this he ascribed to a blow given by an invisible hand. He was afterwards seized by fits; during which he declared, with a roaring voice, that he was the devil, and sung different songs in a variety of keys. The fits always began and ended with a strong agitation

agitation of the right hand. He frequently uttered dreadful execrations during the fits. The whole duration of his disorder was eighteen years.

"At length, viz. in June 1788, he declared that he was possessed by seven devils, and could only be freed by the prayers *(in faith)* of seven clergymen. Accordingly the requisite force was summoned, and the patient sung, swore, laughed, and barked, and treated the company with a ludicrous parody on the *Te Deum*. These astonishing symptoms resisted both hymns and prayers, till a *small, faint, voice* admonished the ministers to adjure. The spirits, after some murmuring, yielded to the adjuration, and the happy patient returned thanks for his wonderful cure. It is remarkable, that during this solemn mockery, the fiend swore, 'by his infernal den,' that he would not quit his patient; an oath, I believe, nowhere to be found but in the Pilgrim's Progress, from which Lukins probably got it.

"Very soon after the first relation of this story was published, a person, well acquainted with Lukins, took the trouble of undeceiving the public with regard to his pretended disorder, in a plain, sensible narrative of his conduct. He asserts, that Lukins's first seizure was nothing else than a fit of drunkenness; that he always foretold his fits, and remained sensible during their continuance; that he frequently saw Lukins in his fits, 'in every one of which, except in singing, he performed not more than most active young people can easily do;' that he was detected in an imposture with respect to the clenching of his hands; that after money had been collected for him, he got very suddenly well; that he never had any fits while he was at St George's Hospital in London; nor when visitors were excluded from his lodgings, by desire of the author of the Narrative; and that he was particularly careful never to hurt himself by his exertions during the paroxysm.

"Is it for the credit of this philosophical age, that so bungling an imposture should deceive seven clergymen into a public act of exorcism? This would not have passed even on the authors of the *Malleus Maleficarum;* for they required signs of supernatural agency, such as the suspension of the possessed in the air, without any visible support, or the use of different languages, unknown to the demoniac in his natural state."

POSSESSIVE, in grammar, a term applied to pronouns, which denote the enjoyment or possession of any thing either in particular or in common: as *meus*, "mine;" and *tuus*, "thine."

POSSESSORY ACTION, in Scots law. See LAW, nº clxxxiii. 18.

POSSIBILITY, in law, is defined to be any thing that is altogether uncertain, or what may or may not be.

POSSIBILITY, also denotes a non-repugnance to existing, in any thing that does not any way exist.

POSSIBLE, is sometimes opposed to real existence, and is understood of a thing, which, though it actually does not exist, yet may exist; as a new star.

POSSIDONIA, (anc. geog.) See POESTUM.

POST, a word derived from the Latin *positus*, "set or placed." It is used in several different meanings, but all of them referring either immediately or remotely to this primitive sense of *position*. Thus the word Post signifies, 1. A stake or piece of timber set upright; 2. A station, particularly a military station; 3. An office or employment; 4. An operation in book-keeping; 5. A conveyance for letters or dispatches; 6. A particular mode of travelling.

POST, a stake or piece of timber set upright. Posts are used both in building and in fencing ground. In brick-buildings much of the strength of the fabric depends on the nature of the posts; as it is through them that the several parts are sustained and held together. The *corner posts* are called the *principal posts;* those formed into bressummers between principal posts for strengthening the carcase of the house are called the *prick-posts*. Posts which are to be set in the ground ought to be well seasoned and coated to preserve them from rotting; burning the downward end has been recommended as an excellent preservative, but a coating of pitch or tar, particularly the late invented coal-tar, can be most safely relied upon. For the various uses to which posts may be applied, and the form and species of them fittest to be employed in each case, see the articles ARCHITECTURE, JOINING, GARDENING, HOUSE, FENCE, &c. In architecture and sculpture POSTS are a term used to denote certain ornaments formed after the manner of rolls or wreathings.

POST, a station, particularly a military station.—Any place where persons are set or placed upon particular occasions may be termed a *post;* but the word in this view is now chiefly restricted to military operations, and means any place or situation where soldiers are stationed. Thus the detachments established in front of the army are termed the *out-posts*, the stations on the wings of the army are said to be the *posts of honour*, as being the most conspicuous and most exposed. But in the operations of a campaign, a post properly signifies any spot of ground capable of lodging soldiers, or any situation, whether fortified or not, where a body of men may make a stand and engage the enemy to advantage. The great advantages of good posts, in carrying on war, as well as the mode of securing them, are only learned by experience. Barbarous nations disdain the choice of posts, or at least are contented with such as immediately fall in their way; they trust solely or chiefly to strength and courage: and hence the fate of a kingdom may be decided by the event of a battle. But enlightened and experienced officers make the choice of posts a principal object of attention. The use of them is chiefly felt in a defensive war against an invading enemy; as by carrying on a war of posts in a country where this can be done to advantage, the most formidable army may be so harassed and reduced, that all its enterprises may be rendered abortive. Indeed in modern times this is so well understood, that pitched battles have become much more rare than formerly, manœuvring and securing of posts being considered as the most essential objects in the conduct of a campaign; a change in the art of war much to the advantage of humanity; skill, conduct, and prudence, having thus obtained the ascendency over brutal courage and mere bodily strength. In the choice of a post, the general rules to be attended to are, that it be convenient for sending out parties to reconnoitre, surprise, or intercept the enemy; that if possible it have some natural defence, as a wood, a river, or a morass, in front or flank, or at least that it be

be difficult of accefs and fufceptible of fpeedy fortification; that it be fo fituate as to preferve a communication with the main army, and have covered places in the rear to favour a retreat; that it command a view of all the approaches to it, fo that the enemy cannot advance unperceived and reft concealed, while the detachment ftationed in the poft are forced to remain under arms; that it be not commanded by any neighbouring heights; and that it be proportioned in extent to the number of men who are to occupy and defend it. It is not to be expected that all thefe advantages will often be found united; but thofe pofts ought to be felected which offer the greateft number of them. See War, *Index*.

Post, an office or employment. This ufe of the word is probably derived immediately from the idea of a military ftation; a poft being ufed to exprefs fuch offices or employments as are fuppofed either to expofe the holder to attack and oppofition, or to require abilities and exertion to fill them. Hence the term is ufed only for *public* offices, and employments under the government; and were ftrict propriety of fpeech always attended to, *pofts* would denote thofe ftations only in which duty muft be performed. In common language, however, every *public* office or appointment, even though nominal and finecure, goes under the name of a *poft*.

Post, an operation in book-keeping. Pofting in book-keeping means fimply the transferring an article to the place in which it fhould be put, and arranging each under its proper head. It is upon this that the whole theory of book-keeping is founded. The Wafte-book, which is the groundwork of all fubfequent operations, records every tranfaction exactly in the order in which it occurs. From this the feveral articles are pofted, or transferred into the Journal, which in fact is but a kind of fupplementary book to the Wafte-book. From the Journal they are pofted anew into the Ledger; in which a feparate place is appropriated for each perfon with whom tranfactions are carried on, and frequently for every feparate article about which the bufinefs is concerned. The particular mode according to which fuch transferences are made, may vary according to the nature of the trade carried on; the object is the fame in all, to place every article fo as that its operations on the general ftate of the bufinefs may be certainly known and diftinctly traced. For a full account of the way in which this is done, fee *Book-Keeping*.

Post, a conveyance for letters or difpatches.

In the early periods of fociety, communication between the different parts of a country is rare and difficult, individuals at a diftance having little inclination or opportunity for mutual intercourfe: when fuch communication is at any time found neceffary, a fpecial meffenger muft be employed. As order and civilization advance, occafions of correfpondence multiply. In particular, the fovereign finds it requifite frequently to tranfmit orders and laws to every part of the kingdom; and for doing fo he makes ufe of couriers or meffengers, to whom he commits the charge of forwarding his difpatches. But without ftations in the way, where thefe couriers can be certain of finding refrefhment for themfelves and fupplies of what may be neceffary for carrying them forward, the journey, however urgent and important, muft always be retarded, and in many cafes altogether ftopped. Experience, therefore, foon pointed out the neceffity of enfuring fuch accommodations, by erecting upon all the great roads houfes or ftations at convenient intervals, where the meffengers might ftop, as occafion required, and where too, for the greater convenience, relays of frefh horfes fhould always be in readinefs, to enable them to purfue their journey with uninterrupted difpatch. Thefe houfes or ftations were with great propriety termed *pofts*, and the meffenger who made ufe of them a *poft*. Though at firft, it is probable, the inftitution was intended folely for the fovereign and the neceffities of the ftate; yet by degrees individuals, feeing the benefit refulting from it, made ufe of the opportunity to carry on their own correfpondence; for which they were willing to pay an allowance to the fovereign. Thus a poft-office, of fome kind or other, gradually came to be eftablifhed in every civilized country. Without taking notice of the different means of carrying on correfpondence faid to have been attempted by pigeons, dogs, and other animals, we can at leaft trace with certainty the invention of fomething like regular pofts as far back as the ancient Perfians. Xenophon affures us, that they were invented by Cyrus on his Scythian expedition, about 500 years before Chrift; that the houfes at the feveral ftations were fumptuoufly built, and large enough to contain a number of men and horfes; and that every courier on his arrival was obliged to communicate his difpatches to the poftmafter, by whom they were immediately forwarded. From the fhore of the Egean fea to Sufa the capital, there were, according to Herodotus, 111 ftages for pofts, each a day's journey diftant from the preceding.

In what manner pofts were eftablifhed and conducted among the Greeks does not clearly appear; but from the extended commerce carried on, and the frequent communications enjoyed among the different ftates, there can be no doubt that a regular conveyance, in fome form or other, was eftablifhed.

Though pofts were well known among the Romans, yet it is difficult to trace with certainty the period of their introduction. Some writers carry it back to the times of the republic; pofts and poft-offices, under the names of *ftatores* and *ftationes*, having been then, it is faid, eftablifhed by the fenate. Whether this was the cafe or not, Suetonius affures us that Auguftus inftituted pofts along all the great roads of the empire. At firft the difpatches were conveyed from poft to poft by young men who run on foot, and delivered the difpatch to others at the next ftage. By and by Auguftus fubftituted, in room of thefe, horfes and chariots, both for the conveyance of difpatches and the convenience of travelling. His fucceffors continued the fame eftablifhment; to the maintenance of which every fubject of the empire was obliged to contribute. Poft-horfes are mentioned in the Theodorian code *de curfu publico;* but thefe were only the public horfes appointed to be kept there for the ufe of the public meffengers, who before this inftitution feized any that came in their way. At each poft-ftation, according to Procopius, 10 horfes and as many poftilions were kept, and the ufual rate of their travelling was from five to eight ftations a-day.

It is to be obferved, however, that all thefe eftablifhments of pofts in ancient times were formed as much, if not more, for travelling ftations, than for the mere con-

conveyance of letters and difpatches. This latter object, it is true, was thereby fecured; but the epiftolary correfpondence of antiquity was probably at no time fo extenfive as to require or maintain poft-offices on the footing of modern pofts, for the mere conveyance of letters. It is in later times only, when the extenfion of commerce and diffufion of literature gave occafion to frequent communication, that thefe eftablifhments are to be looked for.

The earlieft inftitution of *pofts* that occurs in modern hiftory is about the year 807 by the emperor *Charlemagne*; who, having reduced under his dominion Italy, Germany, and a part of Spain, eftablifhed three public pofts at the public expence, to carry on the communication with thefe three provinces. The inftitution of pofts, however, like many other inftitutions of that emperor, dropped at his death, and for a confiderable time afterwards no traces of any fuch eftablifhment are to be found. We cannot indeed difcover them with certainty fooner than 1464, when that reftlefs and fufpicious prince Louis XI. eftablifhed pofts in France, that he might be the fooner advertifed of all that paffed in his own or the neighbouring kingdoms. He employed in this fervice 230 couriers, who delivered the letters at the different ftations, and in the various towns through which they paffed in their courfe. Succeeding monarchs created at different times certain offices for the exprefs purpofe of fuperintending the pofts; but the frequent changes to which thefe offices were expofed, prevented for a long time the eftablifhment of any regular fyftem of pofts in that kingdom; infomuch that in 1619 the author of the life of the duke d'Epernon fays the packet or letter-office was not yet fet up in France. Former eftablifhments, it is probable, were folely for the ufe of the court, not for the general good of the nation. From France, the inftitution gradually fpread through feveral other parts of Europe. In Germany, Lewis Hornig affures us they were firft introduced by Count Taxis, who fettled them at his own expence; in acknowledgment for which the Emperor Matthias in 1616 gave as a fief the office of poftmafter to him and his defcendants.

In England, the eftablifhment of pofts in fome form or other appears as early as the reign of Edward III. but the notices concerning them are fo vague, that no account can be given of them. In the reign of Edward VI. however, fome fpecies of pofts muft have been fet up, as an act of parliament paffed in 1548, fixing the rate of poft-horfes at one penny *per* mile: The poft-horfes here referred to were, it is probable, chiefly for travelling, and the carriage of letters or packets only an occafional fervice. In 1581, we find in Camden's Annals mention made of a chief poftmafter for England being appointed.—How his office was managed, does not clearly appear; the limited ftate of the correfpondence of the country, probably rendered it of trifling confequence. King James I. originally erected a poft-office, under the controul of one Matthew de Quefter or de l'Equefter, for the conveyance of letters to and from foreign parts; which office was afterwards claimed by Lord Stanhope; but was confirmed and continued to William Frizel and Tho. Witherings, by king Charles I. in 1632. Previous to this time, it would appear that private perfons were in ufe to convey letters to and from foreign parts; all fuch interference with the poftmafter's office is therefore exprefsly prohibited. King Charles, in 1635, erected a letter-office for England and Scotland, under the direction of the above Thomas Witherings. The rates of poftage then eftablifhed were, two-pence for every fingle letter for a diftance under 80 miles; four-pence from 80 to 140 miles; fixpence above 140 miles. The allowance to the poftmafters on the road for horfes employed in thefe pofts was fixed at two-pence halfpenny *per* mile for every fingle horfe. All private inland pofts were difcharged at this time; and in 1637 all private foreign pofts were in like manner prohibited. The pofts thus eftablifhed, however, extended only to a few of the principal roads; and the times of tranfmiffion were not in every cafe fo certain as they ought to have been.

Witherings was fuperfeded for abufes in the execution of his offices in 1640, and they were fequeftrated into the hands of Philip Burlamachy, to be exercifed under the care and overfight of the king's principal fecretary of ftate. On the breaking out of the civil war, great confufions and interruptions were neceffarily occafioned in the conduct of the letter-office: but it was about that time that the outline of the prefent more extended and regular plan feems to have been conceived by Mr Edmond Prideaux, who was afterwards appointed attorney-general to the commonwealth. He was chairman of a committee in 1642 for confidering the rate of poftage to be fet upon inland letters; and fome time after was appointed poftmafter by an ordinance of both houfes of parliament; in the execution of which office he firft eftablifhed a *weekly* conveyance of letters into *all* parts of the nation. In 1653, this revenue was farmed for L. 10,000 for England, Scotland, and Ireland; and after the charge of maintaining poftmafters, to the amount of L. 7000 *per annum*, was faved to the public. Prideaux's emoluments being confiderable, the common council of London endeavoured to erect another poft-office in oppofition to his; but they were checked by a refolution of the houfe of commons, declaring that the office of poftmafter is, and ought to be, in the fole power and difpofal of the parliament. This office was farmed by one Maubey in 1654. In 1656 a new and regular general poft-office was erected by the authority of the protector and his parliament, upon nearly the fame model that has been ever fince adopted, with the following rates of poftage: For 80 miles diftance, a fingle letter two pence; for a greater diftance, not out of England, three pence; to Scotland, four pence. By an act of parliament paffed foon after the reftoration in 1660, the regulations fettled in 1656 were re-eftablifhed, and a general poft-office fimilar to the former, but with fome improvements, was erected. In 1663 the revenue of the poft-office was found to produce L. 21,500 annually. In 1685 it was made over to the king as a branch of his private income, and was then eftimated at L. 65,000 *per annum*. The year after the revolution the amount of the poft-office revenue was L. 90,504 : 10 : 6. At the union the produce of the Englifh poft-office was ftated to be L. 101,101. In 1711 the former eftablifhments of feparate poft-offices for England and Scotland were abolifhed; and by the ftat. 9 Anne, c. 10. one general poft-office, and one poftmafter-general, was eftablifhed for the whole united kingdom; and this poftmafter was empowered to erect chief letter-offices at *Edinburgh*, at *Dublin*,

Post. *Dublin*, at *New York*, and other proper places in America and the West Indies. The rates of postage were also increased at this time as follows.—In England, for all distances under 80 miles 3 d.; above 80 miles 4 d. From London to Edinburgh 6 d. In Scotland, under 50 miles 2 d.; from 50 to 80 miles 3 d.; above 80 miles 4 d. In Ireland, under 40 miles 2 d.; above 40 miles 4 d.—By the above act all persons, except those employed by the postmaster, were strictly prohibited from conveying letters. That year the gross amount of the post-office was L. 111,461 17s. 10d. The nett amount, on a medium, of the three preceding years, was, in the printed report of the commissioners, for the equivalent stated to be for England, L. 62,000, and for Scotland L. 2000. In 1754 the gross revenue of the post-office for Great Britain amounted to L. 210,663, in 1764 to L. 281,535, and in 1774 to L. 345,321.—The privilege of franking letters had been enjoyed by members of parliament from the first erection of the post-office; the original design of this exemption was, that they might correspond freely with their constituents on the business of the nation. By degrees the privilege came to be shamefully abused, and was carried so far, that it was not uncommon for the servants of members of parliament to procure a number of franks for the purpose of selling them; an abuse which was easily practised, as nothing more was required for a letter's passing free than the subscription of a member on the cover. To restrain these frauds, it was enacted, in 1764, that no letter should pass free unless the whole direction was of the member's writing, and his subscription annexed. Even this was found too great a latitude; and by a new regulation in 1784, no letter was permitted to go free unless the date was marked on the cover in the member's own hand-writing, and the letter put into the post-office the same day. That year the rates of postage were raised in the following proportions: an addition of 1 d. for a single stage; 1 d. from London to Edinburgh; 1 d. for any distance under, and 2 d. for any distance above, 150 miles. An addition to the revenue of L. 120,000 was estimated to arise from these regulations and additional rates. In all the statements of duties upon postage of letters given in this account, the rates mentioned are those upon single letters, double letters pay double, treble letters treble, an ounce weight quadruple postage; all above are charged by the weight in the same proportion.

About the year 1784, a great improvement was made in the mode of conveying the mails, upon a plan first suggested in 1782 by Mr John Palmer. Diligences and stage-coaches, he observed, were established to every town of note in the kingdom; and he proposed that government, instead of sending the mails in the old mode, by a boy on horseback, should contract with the masters of these diligences to carry the mail, along with a guard for its protection. This plan, he showed, could not fail to ensure much more expeditious conveyance, the rate of travelling in diligences being far quicker than the rate of the post; and it was easy to carry it into execution with little additional expence, as the coach owners would have a strong inducement to contract at a cheap rate for conveying the mail, on account of the additional recommendation to passengers their carriages would thereby acquire in point of security, regularity, and dispatch.

Tho' government heartily approved of this plan, and the public at large were satisfied of its utility; yet, like all new schemes, however beneficial, it met with a strong opposition: it was represented by a number of the oldest and ablest officers in the post-office, not only as impracticable, but dangerous to commerce and the revenue. Notwithstanding of this opposition, however, it was at last established, and gradually extended to many different parts of the kingdom; and, upon a fair comparison, it appeared that the revenue was improved, and the plan itself executed for L. 20,000 *per annum* less than the sum first estimated by Mr Palmer.

The present establishment of the general post-office for Great Britain, consists of two postmasters-general, a secretary, surveyor, comptroller-general, and upwards of 150 assistants and clerks for the head letter office in London; the number of deputy postmasters and other officers through the kingdom is very considerable, but not easy to ascertain with accuracy, as it must frequently vary with the changes made in the establishment of country posts. The total expence of this branch of the revenue in 1788 was L. 149,029, 17 s. 2 d. the gross produce may now be reckoned at L. 650,000.

The first accounts we have of the establishment of a post-office in Scotland reach no farther back than 1635, when Charles I. erected one both for Scotland and England. The post to Scotland by that appointment was to run night and day, to go from London to Edinburgh and to return in *six* days, taking with it all letters intended for any post-town in or near the road; the rate of postage from London to Edinburgh was 8 d. for a single letter. The expedition with which the post went from London to Edinburgh at this time, is indeed surprising, considering the nature of the roads; perhaps, however, though the king made the regulation that it should go and return in six days, the journey was not always performed in the specified time. During the government of Cromwell, the public post conveyed letters to Scotland as well as England; the postage from London to Scotland was only 4d. After the Restoration, when the post-office was erected for England, mention is made in the act of parliament of the conveyance of letters to Scotland; and the postage to Berwick is fixed at 3d. For some time after, however, we find no establishment by act of parliament of an internal post in Scotland. In 1662, a post between Ireland and Scotland was first established; and the privy council gave Robert Main, who was then postmaster-general for Scotland, an allowance of L. 200 Sterling to build a packet-boat for conveying the mail between Portpatrick and Donaghadee: the postage to Ireland was 6d. In 1669, a post was established to go between Edinburgh and Aberdeen twice a-week, and between Edinburgh and Inverness once a-week: the rate of postage was fixed, for 40 Scots miles 2d. and for every 20 miles farther an additional penny. These appear to have been the only *public* posts in Scotland at that time; but as they could not suffice for the correspondence of the country, there must have been more, either under the direction of the postmaster, or in the hands of private persons; probably there might be of both kinds. In 1690, an act for the security of the common post was passed, subjecting robbers of the mail to capital punishment. It was not till 1695 that the establishment of the post-office in Scotland received the

Post.

sanction of parliament: posts were then appointed for all parts of Scotland; the rates of postage were fixed, for any place within 50 miles of Edinburgh 2 d. between 50 and 100 miles 3d. all places above 100 miles 4 d. By the same act, a weekly packet to Ireland was established, and L. 60 Sterling annually allowed for that service. Though posts were established in consequence of this act, yet such was their mode of travelling, that they hardly deserved the name. Thus, for instance, the person who set out to carry the mail from Edinburgh to Aberdeen, in place of stopping at the first intermediate stage from Edinburgh, and delivering over the mail to another, to be carried forward, went on with it himself the whole journey, resting two nights by the way, first at Dundee, and next at Montrose.

In this manner the mail was conveyed thrice a-week from Edinburgh to Aberdeen; but between most parts of Scotland the post went only twice, and between some only once a-week. The post-boy generally travelled on foot. Horses were but little used in the service of the post-office.

At the Union, the Scots post-office was farmed for L. 1194: in 1710, the nett amount for Scotland was reckoned to be L. 2000. The epistolary correspondence of Scotland must have been small indeed, when even the rates of postage then established proved so very unproductive. This may perhaps, however, be in part accounted for, by conjecturing, that as private posts had probably prevailed pretty much before 1695, it was long before these were entirely suppressed, the people still adhering to their old conveyances, and difficulties occurring in strictly enforcing the law; the amount of the post-office revenue, therefore, at the two periods above-mentioned probably exhibits a view of only a part of the correspondence of Scotland.

In 1711, it has been already mentioned, one general post-office was established for the whole united kingdom; but the postmaster-general was authorised to erect at Edinburgh a chief letter office for Scotland.—This was accordingly done, and a postmaster-general for North Britain, with other necessary officers, appointed. All the deputy postmasters in Scotland are under his immediate direction, but he himself is under the controul of the postmaster-general for Great Britain. From this head letter office posts were established to the different parts of Scotland.

For many years the post-boys generally travelled on foot, or if on horseback, without a change of horses. It was not till about 1750 that the mail began to be conveyed from stage to stage by different post-boys and fresh horses to the principal places in Scotland, and by foot runners to the rest. The communication between London and Edinburgh was at first but thrice a-week, and so slow, that the mail from London to Edinburgh was upon the road 85 hours, and from Edinburgh to London 131 hours. In 1757, upon a representation from the royal boroughs, regulations were fallen upon, by which the time was shortened to 82 hours in the one case, and 85 in the other. By the extension of Mr Palmer's plan to Scotland, the time has been still farther shortened to about 60 hours in each case.

The establishment of the Scots post-office, which has been gradually enlarged as the state of the country required, consists at present of a postmaster-general, secretary, solicitor, and accountant, with a number of other clerks and assistants for the head office at Edinburgh; under its management are about 180 deputy-postmasters for the different post-towns through Scotland.

The nett produce of the post-office for Scotland in 1733 was L. 5399, in 1754 L. 8927, in 1757 L. 10,623, in 1760 L. 11,942, in 1776 L. 31,103. In 1788 the gross produce was L. 55,836, the expence L. 22,636, 13 s. 6 d.; in 1793 the gross amount was about L. 64,000, the nett produce about L. 40,000.

Penny-Post, a post established for the benefit of London and other parts adjacent, whereby any letter or parcel under 16 ounces weight, or L. 10 value, is speedily and safely conveyed to and from all places within the bills of mortality, or within 10 miles of the city. It is managed by particular officers, and receiving houses are established in most of the principal streets, for the more convenient transmission of the letters. Some other large towns have instituted similar establishments.

About 20 years ago a penny-post was set up in Edinburgh by an individual, unconnected with the general post-office. It met with but indifferent encouragement for some years, doubts being entertained as to its punctuality in delivering the letters; by degrees, however, it seemed to be advancing in estimation, and was more frequently employed. About a year ago, the general post-office, in virtue of the act of parliament prohibiting the conveyance of letters by any but those employed under the postmaster-general, took the penny-post entirely into its own hands; and at present letters are transmitted from the general post-office to the different quarters of Edinburgh and the suburbs, three or four times a-day.

Post, a particular mode of travelling. A person is said to *travel post*, in contradistinction to common journey travelling, when, in place of going on during his whole journey in the same vehicle, and with the same horses, he stops at different stages, to provide fresh horses or carriages for the sake of greater convenience and expedition. As he thus uses the same mode of travelling that is employed for the common post, he is said to travel post, or in post, *i. e.* in the manner of a post.

In tracing the origin of posts, it has been already remarked, that the more ancient establishments of this kind were fully as much for *travelling stations* as the conveyance of letters. The relays of horses provided at these public stations for the messengers of the prince, were occasionally, by special licence, allowed to be used by other travellers who had sufficient interest at court. Frequent demands of this nature would suggest the expedient of having in readiness supplies of fresh horses or carriages over and above what the *public* service required, to be hired out to other travellers on payment of an adequate price. We find, therefore, that in former times the postmasters alone were in use to let out horses for riding post, the rates of which were fixed in 1548 by a statute of Edward VI. at one penny *per* mile. In what situation the state of the kingdom was with regard to travelling post for more than a century after this period, we cannot now certainly discover; but in the statute re-establishing the post-office in 1660, it is enacted, that none but the postmaster, his deputies, or assigns, shall furnish post-horses for travellers; with a proviso, however, that if he has them not ready in half an hour

Poſt.

after being demanded, the traveller ſhall be at liberty to provide himſelf elſewhere.

The ſame prohibition is contained in the act eſtabliſhing the Scots poſt-office in 1695, as well as in the ſubſequent act of Queen Anne, erecting the general office for the united kingdom. It is doubtful, however, whether it ever was ſtrictly enforced. By an explanatory act of 26 Geo. II. the prohibition is confined to poſt *horſes* only, and every perſon declared to be at liberty to furniſh *carriages* of every kind for riding poſt. This regulation has, in fact, done away the prohibition, as hardly any perſon now thinks of travelling poſt except in a carriage.

The rate fixed by the act 1695, in Scotland, for a horſe riding poſt, was three-pence *per* Scotch mile. By the act 9 Anne, c. 10. three-pence a-mile without, and four-pence a-mile with, a guide, was the ſum fixed for each horſe riding poſt. The increaſe of commerce, and neceſſity for a ſpeedy communication between different parts of the kingdom, have brought the mode of travelling poſt ſo much into uſe, that upon every great road in the kingdom poſt-chaiſes are now in readineſs at proper diſtances; and the convenience of poſting is enjoyed in Britain to a degree far ſuperior to what is to be met with in any other country whatever.

Poſting at laſt appeared to the legiſlature a proper object of taxation. In 1779 the firſt act was paſſed, impoſing duties on horſes hired either by themſelves or to run in carriages travelling poſt: the duties were, one penny *per* mile on each horſe if hired by the mile or ſtage, and one ſhilling *per* day if hired by the day. Every perſon letting out ſuch horſes was alſo obliged to take out a licence at five ſhillings *per annum*. Theſe duties were next year repealed, and new duties impoſed, of one penny *per* mile on each horſe hired by the mile or ſtage, and 1s. 6d. on each if hired by the day. A number of additional regulations were at the ſame time enacted for ſecuring theſe duties. An addition of one halfpenny *per* mile, or three-pence *per* day, for each horſe riding poſt, was impoſed in 1785, by Stat. 25 Geo. III. c. 51. The duty is ſecured, by obliging every letter of horſes to deliver to the perſon hiring them a ticket, expreſſing the number of horſes hired, and either the diſtance in miles to be travelled, or that the horſes are hired by the day, as the caſe happens to be. Theſe tickets muſt be delivered to the bar-keeper at the firſt turnpike through which the traveller paſſes; and the turnpike-keeper gives, if demanded, what is termed an *exchange* ticket, to be produced at the next turnpike. The ſtamp-office iſſues to the perſon licenſed to let poſt-horſes ſuch a number of theſe tickets as is required, and theſe muſt be regularly accounted for by the perſon to whom they are iſſued. As an effectual check upon his account, the turnpike-keeper is obliged to return back to the ſtamp-office all the tickets he takes up from travellers. Evaſions are by theſe means rendered difficult to be practiſed without running a great riſk of detection. In 1787, for the more effectually levying the poſt-horſe duties, a law was paſſed, authoriſing the commiſſioners of the ſtamp-office to let them to farm by public auction, for a ſum not leſs than the produce in the year ending 1ſt Auguſt 1786.

In the advertiſement publiſhed by the commiſſioners in conſequence of this law, previous to the receiving propoſals for farming them, the total amount of the duty for Great Britain is ſtated to have been, at the period above referred to, L. 119,873. The ſum for which that duty was farmed in 1794 amounted in all to L. 140,030, of which the diſtrict of North Britain was L. 6000.

Soon after the tax was impoſed, conſiderable difficulties were raiſed about the meaning of the term *poſting*, and what mode of journeying ſhould ſubject travellers to duty. The old law, Stat. 9 Anne, c. 10. explained poſting to be "travelling ſeveral ſtages, and changing horſes;" but the acts impoſing the poſting duties expreſsly declare, that "every horſe hired by the mile or ſtage ſhall be deemed to be hired to travel poſt, although the perſon hiring the ſame doth not go ſeveral ſtages upon a poſt road, or change horſes;" and that "every horſe hired for a day or leſs period of time, is chargeable with the duty of three halfpence *per* mile, if the diſtance be then aſcertained; and if the diſtance be not then aſcertained, with 1s. 6d. each horſe." Horſes hired for any leſs time than two days are by theſe acts to be deemed to be hired for a day. An action was brought in 1788, in the court of exchequer at Edinburgh, to determine whether ſeveral diſputed caſes fell under the meaning of the act, and were liable to duty; when the following deciſions were given:

Saddle-horſes both hired and paid by the mile, and ſaddle-horſes hired originally for an excurſion, but afterwards paid by the mile, were found liable to duty according to the number of miles paid for; carriage-horſes, where the carriage is hired and paid for only at the uſual rate of *outgoing* carriages, and no more, whether the perſon hiring it does or does not return in it, were found liable to duty only for the number of miles *out*; but if the carriage be hired and paid for, or actually paid for though not originally hired, at the uſual rate of carriages employed both to carry out and bring back the ſame company, the duty was found to be exigible according to the number of miles both out and home taken together. Hackney-coaches in Edinburgh, hired and paid for leſs than two miles, were found liable to duty for one mile.

No duty was found to be exigible on ſaddle-horſes hired for a mere excurſion, and paid for accordingly, where the diſtance neither is nor can be aſcertained; on hackney-coaches employed in the ſtreets for leſs than a mile, or for an excurſion or round of viſits merely; and on horſes or carriages hired for a journey of three days or more, and paid for accordingly, or paid for at the rate of three days, though the journey ſhould actually be performed in two full travelling days. The general rule of theſe deciſions was, that in every caſe, except unaſcertainable diſtance, or journeys exceeding two days, the mode of travelling fell under the legal definition of poſting. The only point that may ſeem doubtful in the judgments here ſtated, is that where the duty is found chargeable by the number of miles both going and returning. Yet as the law expreſsly declares, that horſes hired by the mile or ſtage are to be deemed *poſting*, and as the number of miles for which they are hired can only be aſcertained by the number paid for, it is clear, that where an addition to the outgoing charge is made on account of bringing back the perſon hiring the carriage, the carriage in that caſe is actually hired and paid for according to the number of miles both out and home, and the duty muſt fall to be rated accordingly.

ingly. The doubtful points being now settled by the above decisions, the mode of levying the duty in Scotland has been regulated agreeably to them ever since the matter was thus determined.

POSTERIOR, a term of relation, implying something behind, or that comes after, another. In which sense it is used in opposition to *prior* and *anterior*.

The back and hips are the posterior parts of man. Aristotle has given prior and posterior analytics. A date is posterior to another, when it is later or fresher.

POSTERN, in fortification, a small gate, usually made in the angle of the flank of a bastion, or in that of the curtain, or near the orillon, descending into the ditch; whereby the garrison can march in and out, unperceived by the enemy, either to relieve the works, or to make private sallies, &c.

The word is also used in the general for any private or back-door.

POSTHUMOUS, a child born after the death of his father, or taken out of the body of a dead mother; from whence it is frequently applied to the works of an author not published till after his decease.

POSTIL, a name anciently given to a note in the margin of the Bible, and afterwards to one in any other book posterior to the text.

POSTING, among merchants, the putting an account forward from one book to another, particularly from the journal or waste-book to the ledger. See Post and Book-Keeping.

POSTLIMINIUM, among the Romans, the return of one who had gone to sojourn elsewhere, or had been banished, or taken by an enemy, to his own country or state.

POSTPONING, putting any thing after or behind another with regard to time.

POSTSCRIPT, an article added to a letter or memoir, containing something learnt or recollected after the piece was written.

POSTULATE, in mathematics, &c. is described to be such an easy and self-evident supposition, as needs no explication or illustration to render it intelligible; as that a right line may be drawn from one point to another.

POSTURE, in painting and sculpture, the situation of a figure with regard to the eye, and of the several principal members thereof with regard to one another, whereby its action is expressed. A considerable part of the art of a painter consists in adjusting the postures, in giving the most agreeable ones to his figures, in accommodating them to the characters of the respective figures, and the part each has in the action, and in conducting and in pursuing them throughout.

Postures are either natural or artificial.

Natural postures are such as nature seems to have had a view to in the mechanism of the body, or rather such as the ordinary actions and occasions of life lead us to exhibit while young, and while the joints, muscles, ligaments, &c. are flexible.

Artificial postures, are those which some extraordinary views or studies occasion us to learn; as those of dancing, fencing, &c. Such also are those of our balance and posture masters.

A painter would be strangely puzzled with the figure of Clark (a late famous posture-master in London) in a history-piece. This man, we are told in the Phil. Transf. had such an absolute command of his muscles, &c. that he could disjoint almost his whole body; so that he imposed on the great surgeon Mullens, who looked upon him as in such a miserable condition, he would not undertake his cure. Though a well-made man, he would appear with all the deformities imaginable; hunch-backed, pot-bellied, sharp-breasted, &c. He disjointed his arms, shoulders, legs, and thighs; and rendered himself such an object of pity, that he has frequently extorted money, in quality of a cripple, from the same company in which he had the minute before been in quality of a comrade. He would make his hips stand a considerable way out from his loins, and so high as to invade the place of his back. Yet his face was the most changeable part about him, and showed more postures than all the rest. Of himself he could exhibit all the uncouth odd faces of a Quaker's meeting.

POTAMOGETON, pond-weed: A genus of the tetragynia order, belonging to the tetrandria class of plants; and in the natural method ranking under the 15th order, *Inundatæ*. There is no calyx; but four petals; no style, and four seeds There are 12 species, all of them floating vegetables on the surfaces of stagnant waters, affording an agreeable shade to fish, and food to cattle.

POTAMON or Potamo, was a philosopher of Alexandria. He kept a middle course between the scepticism of the Pyrrhonians and the presumption of the dogmatists; but attached himself to none of the schools of philosophy of his time. He was the first projector of the Eclectic sect; for though that mode of philosophising had been pretty common before, he was the first that attempted to institute a new sect on this principle. "Diogenes Laertius relates, that not long before he wrote his Lives of the Philosophers, an Eclectic sect, ἐκλεκτική τις αἵρεσις, had been introduced by Potamo of Alexandria, who selected tenets from every former sect. He then proceeds to quote a few particulars of his system from his Eclectic institutes, respecting the principles of reasoning, and certain general topics of philosophical inquiry; from which nothing further can be learned, than that Potamo endeavoured to reconcile the precepts of Plato with those of other masters. As nothing remains concerning this philosopher besides the brief account just referred to in Laertius, an obscure passage in Suidas, and another still more obscure in Porphyry; it is probable that his attempt to institute a school upon the Eclectic plan proved unsuccessful. The time when Potamo flourished is uncertain. Suidas places him under Augustus; but it is more probable, from the account of Laertius, that he began his undertaking about the close of the second century."

Enfield's History of Philosophy.

POTASH, the lixivious ashes of certain vegetables, used in making of glass, soap, &c. See Glass, Soap, &c.

Dr Shaw's method of making potash.

The method of making potash is directed by Dr Shaw as follows.' Burn a quantity of billet-wood to grey ashes; and taking several pounds of these ashes, boil them in water, so as to make a very strong lixivium, or ley. Let this ley be strained through a coarse linen cloth, to keep out any black parts of the half-burnt wood that might happen to remain in the ashes; then evaporate this strained lye in an iron-pan over a quick fire almost to dryness: then taking out the matter remaining

maining at the bottom, and putting it into an iron crucible, ſet it in a ſtrong fire till the matter is melted, and then immediately pour it out upon an iron-plate, where it ſoon cools, and appears in the form of a ſolid lump of potaſh *. Much after this manner is pot-aſh made in the large way of buſineſs, for the ſervice of the ſoap-boiler, glaſs-maker, fuller, &c. but according to the difference of the wood, or cumbuſtible matter employed, with the manner of turning it, and conducting the proceſs, different kinds of potaſh are prepared. There are certain ſaline plants that yield this potaſh to great advantage, as particularly the plant kali; there are others that afford it in leſs plenty, and of an inferior quality, as bean-ſtalks, &c. but in general, all vegetable ſubjects afford it of one kind or other, and may moſt of them be made to yield it tolerably perfect after the manner of the proceſs already laid down, even the loppings, roots, and refuſe parts of ordinary trees, vine clippings, &c. The fixed ſalts of all vegetables excepting the kali and marine plants, when reduced to abſolute purity, or entirely ſeparated from the other principles, appear to be one and the ſame thing: whence it ſhould ſeem, ſays Dr Shaw, that by a ſuitable management, good ſaleable potaſh might be made in all places where vegetable matters abound. For if by examining Ruſſia (A) potaſh, for example, we find that its ſuperior excellence depends upon its being clear of earth, or upon its containing a large proportion of oil, or refined ſalt, theſe advantages may, by properly regulating the operation, be given to Engliſh potaſhes, ſo as perhaps to render the latter as good as the former: but where the potaſh of any remarkable ſaline vegetable is to be imitated, that of the kali, for example, the Doctor recommends a prudent ſprinkling of the ſubject with ſalt, or ſea-water, in the burning; and by theſe ways, peoperly diverſified, any principle that is naturally wanting might be artificially introduced ſo as to perfect the art of potaſh.

2 ...unt of ...Ste- ...'s ma- ...cture.

About 40 years ago or upwards, Mr Stephens, encouraged by the Society of Arts, &c. and by a parliamentary grant of 3000 l. eſtabliſhed a manufacture of pot-aſh in North America, which produced ſuch as was ſo perfectly good as to anſwer in bleaching and other uſes the purpoſes of *pearl-aſh;* and which at the ſame time afforded a very large produce. But the very great heat which his proceſs required, occaſioned the deſtruction of a very extenſive apparatus; and other circumſtances concurred to diſappoint the hopes and check the ſpirit of the proprietors. The manufacture was, however, afterwards undertaken and proſecuted by others. Mr Stephens's apparatus was as follows: Fig. 1. A is the bed of the kiln, which flies off about four feet by two from the grate, more or leſs according to the ſize; C is the aſh-hole, 2½ or 3 feet deep. Fig. 2. B repreſents quadrangular bars of iron, with their oppoſite angles placed upwards and downwards, not above an inch aſunder. Fig. 3. A, B, and C, are three ſteepers five feet deep, and of any width from four to eight feet ſquare, of the beſt white pine or cyprus plank, with ſquare joints and ſtrong oak frames, placed each over a receiver, with a cock to let off the lye, and a vent juſt beneath the ſurface of the grating. E repreſents three receivers, ſtanding each under, and projecting out, from its ſteeper. They muſt be made of the beſt ſtuff, carefully put together, and laid in tough clay well rammed within the ground, their tops being level with the ſurface: they need not be ſo large as the ſteepers by ſix, eight, or twelve inches. Fig. 4. E repreſents a falſe bottom or lattice of boards, eight inches deep and five ſquare, with a hole in the under edge of every partition for the lye to paſs into the ſteeper. Fig. 5. A is the veſſel over the furnace in which the lye and aſhes are mixed; B is a hole or funnel a few inches from the back of the furnace, with an iron ſocket to let the pipe through the hinder part of the arch, to reach down within two inches of the floor of the furnace. C is a caſt iron cauldron for boiling the lye to dryneſs when pearl-aſh is made. D is a veſſel whence the liquor is let into the cauldron as it evaporates. The mortar for building the furnace ſhould be made of loam; the arch ſhould be 18 inches thick, and the floor ſhould be laid with tiles on a layer of ſand an inch thick, with neat joints.

Potaſh.

3 Of his apparatus.

Plate CCXV.

4 Proceſs without uſing a kiln.

Mr Stephens's proceſs, both with and without the kiln, was as follows. Cut timber, felled at any ſeaſon, into lengths of about eight feet; lay from three to ten of them lengthwiſe in a heap upon dry ground, and fill the vacancies between with ſmaller wood: the ſooner it is burnt after felling, the better. Set fire to it by laying embers on the bottom logs at each end; and for burning the bruſh and lappings, with other ſmaller woods, lay them lengthwiſe on the ground, top to top, lapping over a little, with the butt ends outwards, and as cloſe as a faggot; laying the larger woods on top till the heap is full four feet high; the length of the bruſh ſet againſt each other making the breadth of the heap. As to the choice of the timber, old hollow trees, if not dead, are beſt: pine, cyprus, and cedar, are to be totally rejected.

As ſoon as the pile is burnt down, rake ſuch aſhes as lie round the outſide a little in towards the middle; add no freſh fuel, nor throw on any brands. Let the aſhes lie without ſtirring till you can juſt bear your hand in them; then carry them to a houſe, or under a ſhed, on a plank floor raiſed a little from the earth and well jointed;

(A) According to Sir Peter Warren, the beſt woods for making Ruſſia potaſh are, oak, aſh, poplar, hiccory, elm, hazle, and beech. They muſt be cut in November, December, January, and February, ſplit and ſtacked to dry. After 12 months in warm open weather, it muſt be burnt on a brick hearth by a ſlow fire in a kiln, or cloſe place; the aſhes muſt be ſifted through two ſieves, one finer than the other, and then put up in brick troughs or wooden backs, covered with rain or river water, and muſt remain well marſhed and incorporated five months. Brick furnaces ſhaped like bakers ovens muſt be heated with a ſtrong fire of oak or aſh, burning night and day; the prepared aſhes muſt be gradually thrown on the fire, when they will run into metal like lead: the fire muſt not go out till the furnace is nigh filled with potaſhes. The aſhes muſt then be broken to be taken out, but the larger the pieces the better; they muſt be preſerved from the air in tight caſks, the large pieces by themſelves, and the duſt by itſelf.

Potaſh.

jointed; there wet them till brought nearly to the conſiſtence of mortar in the firſt mixture of lime and ſand, and ram them in a heap, in which they muſt lie full 20 days, or ſome months if you pleaſe; obſerving to be more ſparing of water in winter, and ramming them cloſer, and ſometimes wetting the top that it may never grow quite dry.

5 And with it. Plate CCCCXV.

Wood may alſo be burnt in a kiln, as fig. 1 and 2; and then it muſt be cut into ſuch lengths as may be moſt convenient for carriage, and beſt ſuit the ſize of the kiln. The mouth of the aſh-hole muſt be cloſe ſtopped by daubing the joints of the lid with loam, or throwing a bank of ſand or earth againſt it: keep the bed of the kiln filled with wood up to the ſurface, but not above it, and let it burn inceſſantly till the aſhes riſe within ſix or eight inches of the grate. Draw them out whilſt red-hot, and in that ſtate ſprinkle them with lye, from four to ſix caracts weight; weigh a ſmall vial which holds about four ounces very exactly; then fill it with water and weigh that alſo: divide the weight of water into equal parts till you come to $\frac{1}{128}$ of the whole, which is called a *caract*, $\frac{1}{64}$ two caracts, &c. until you have a weight equal to $\frac{1}{4}$ of the whole water, which is called 32 caracts: all which ſmall weights, together with one equal to the phial filled with water, are to be kept for weighing the lye in the ſaid phial till they are made damp; then ram them as before in a heap, but ſeparate from the aſhes made as above. N. B. By kiln-burning a ſtronger lye may be more certainly procured than by the other way, where rain may chance to fall on the aſhes before they can be removed.

The aſhes thus prepared are to be put in vats or ſteepers fig. 3, with a falſe latticed bottom as fig. 4; firſt putting coarſe wheat or rye ſtraw about a foot thick on the lattice or grating; on which put aſhes to within four or five inches of the top, ramming them all the way up, eſpecially at the ſides, with a ſmall light rammer, as tight as you can, without burſting the vat. Form on the top of the ſteeper a hollow baſon in the aſhes four or five inches deep, leaving the aſhes four or five inches thick on the ſides, by raiſing a ſmall bank round the ſides, ſo that the liquor may not overflow the edges of the aſhes at top: keep this baſon conſtantly filled with ſoft water in the ſteeper A, until the aſhes will imbibe no more, which will be in 24 hours or more, according as it is rammed; then turn the cock, and let off what ſhall be ſoaked through into the receiver or lower chamber of the ſteeper, and no more; for if the ſeveral runnings are not kept ſeparate, the lye will not be brought to its due ſtrength. Follow that ſteeper with freſh water on the ſame aſhes for ſeveral other runnings, which will each come off in a few days, till the liquor has neither ſmell nor taſte; then heave out the aſhes, and charge the ſteeper afreſh.

Upon drawing off the firſt running from the ſteeper A, fig. 3, fill the ſteeper B with aſhes as before, and put into its hollow at the top the lye ſo firſt run off, and the ſmaller or half lyes alſo, till full, and draw off as directed for the ſteeper A: if this weighs 18 caracts or more, pump it into the ciſtern F as fit for uſe; if it be ſhort of that, paſs it off as half lye to the ſteeper C, and through freſh aſhes till ſtrong enough. With kiln-aſhes only, from water paſſing through the firſt ſteeper, it will be ſtrong enough for the ciſtern, if the aſhes are well prepared. If your water be hard, let it ſtand two or three days expoſed to the air and ſun in a ſhallow back, and it will be ſoft. When you uſe kiln-aſhes with others, lay them at bottom.

The lye muſt be conveyed from the ciſtern F, as it is wanted to the veſſel A fig. 5; where with every gallon of proof lye mix three ounces of fine, light, wood aſhes; and to the lye that is $\frac{1}{4}$ over-proof put ſix ounces of aſhes; and if $\frac{2}{5}$ over-proof 12 ounces, increaſing or leſſening according to the ſtrength of the lye.

For evaporating the lye and melting the ſalt, heat a furnace till you bring it very near a white heat, of which the ſide-doors being red-hot is a mark. This will take 48 hours or more, if the furnace be quite cold; when thorough hot, a little fuel keeps it ſo. Then, through the cock of the veſſel A, paſs the mixture by the funnel B into the furnace, not ſo as to reach much beyond the middle of the floor, before it changes from dark to bright red, letting the heat prevail towards front or back as you ſee neceſſary. When the maſs begins to gather about the flues or in heaps, run in no more till the furnace is cleared by driving the fire backward. You muſt have two funnels, one ſoon choaking: in an hour or leſs will iſſue out a red-hot ſtream of melted ſalt, which is potaſh, to be broke to pieces as ſoon as cold, and packed in tight cloſe caſks, being in no reſpect inferior to the beſt foreign aſh whatever.

6 Spaniſh potaſh beſt.

The beſt potaſh is made from barilla, and comes from Spain. The plants from which it is procured are found in great plenty about Carthagena, where they are indigenous, and may be collected in a ſwamp called *Almojar* eaſt of that place; the *Sayones* barilla is the beſt. They are found, beſides all along that coaſt, on the borders of the Mediterranean for 60 leagues in length and 8 in breadth. About 150,000 quintals of it are annually exported from Spain. It produces a revenue of 25,500l. a year; each quintal paying a duty of 17 reals: yet Don Bernardo de Ulloa, A. D. 1740, ſays it was farmed at L. 1822, 4s. 3d. M. Macdonnell has brought the manufacture of potaſh to its preſent perfection in Spain; but its exportation is materially injured by the heavy tax on it. See Townſhend's *Travels*, vol. iii. p. 131. See alſo Barilla, Kelp, and Fucus.

7 Dr Percival's account of making potaſh.

In the 70th volume of the Philoſophical Tranſactions we have an account of a method of procuring this ſalt from the putrid water which runs from dunghills. The proceſs is very eaſy, conſiſting only in ſimple evaporation of the fluid, and calcining the impure ſalt till moſt of the foulneſs is burnt out. From 24 wine-pipes full of this muck-water were obtained 9 cwt. 1 q. 12 lb of ſaleable potaſh, valued at 42 s. *per* cwt; the expence of manufacturing them being only valued at 4 l. 9 s.

The potaſh thus made is of a greyiſh white appearance; deliqueſces a little in moiſt air; but if kept in a dry room, near the fire, acquires a powdery ſurface. It is hard and of a ſpongy texture when broken, with many ſmall cryſtals in its ſubſtance. The colour of its internal parts is duſky and variegated. To the taſte it is acrid, ſaline, and ſulphureous. It emits no ſmell of volatile alkali, either in a ſolid form, diſſolved, or when added to lime-water; neither does it communicate the ſapphire-colour to a ſolution of blue vitriol. Silver is quickly tinged black by it; a proof that it contains much phlogiſton. Ten grains of this potaſh required 11 drops of the weak ſpirit of vitriol to ſeparate it.

The

The like quantity of ſalt of tartar required 24 drops: a ſtrong effervеſcence occurred in both mixtures; and a ſulphureous vapour exhaled from the former. A tea ſpoonful of the ſyrup of violets diluted with an ounce of water was changed into a bright green colour by five grains of the ſalt of tartar; but ten grains of this potaſh were neceſſary to produce the ſame hue in a ſimilar mixture. Half an ounce of the ſalt diſſolved entirely in half a pint of hot water; but when the liquor was cold, a large purple ſediment ſubſided to the bottom; and it was found that this ſediment amounted to about two-thirds of the whole quantity of aſhes uſed.

Dr Percival, the author of this paper, concludes with obſerving, that this potaſh is a true fixed vegetable alkali, produced by putrefaction; that the quantity of alkali contained in it may be eſtimated at one-third of its weight, whereas the white Muſcovy aſhes are ſaid to yield only one-eighth part; that no quicklime appears to be contained in this potaſh, for a ſolution of it poured from its ſediment remained clear though long expoſed to the air: that it would be worth trying, whether the large purple ſediment, which ſubſides when this potaſh is lixiviated, might not be applied to the manufacture of Pruſſian blue, or uſed in the manner recommended by Macquer for dyeing wool and ſilks; and that this manufacture will furniſh the farmer for top-dreſſing for his garden and land, of great fertilizing powers. See *Phil. Tranſ.* Vol. LXX. p. 345.

Theſe are the proceſſes moſt eſſentially different from one another which have appeared concerning the manufacture of this uſeful ſalt. Some indeed have attempted to compoſe it on the ſuppoſition that alkali conſiſted of an earth combined in a peculiar manner with a certain acid. But the little ſucceſs of all theſe attempts ſhow that they have been built on a falſe principle. The only method of producing alkaline ſalts originally is from the aſhes of vegetables; and the vegetable ſubſtances which yield the largeſt quantity of them are tartar and marine plants. From the former the pureſt and ſtrongeſt vegetable alkali is obtained, and from the latter the mineral alkali. From other vegetables, as fern, broom, bean-ſtalks, &c. an alkaline ſalt is produced, but ſo impure, and in ſuch ſmall quantity, that no manufacture of it can be eſtabliſhed in this country with any reaſonable expectations of profit.

Dr Watſon (the preſent biſhop of Landaff) ſuggeſts, that the inveſtigation of a method of extracting its alkaline part from rock ſalt would be a moſt ſerviceable diſcovery. We have inexhauſtible mines of rock ſalt in this country, which (he obſerves) the proprietors can afford at ten ſhillings a ton. A ton of rock-ſalt contains about half a ton of mineral alkali, which is for moſt purpoſes far preferable to potaſh. To thoſe who have leiſure to attempt ſuch a diſcovery, he gives the following hint: whether the alkaline part of rock-ſalt may not be obtained by calcining it in conjunction with charcoal in open fires? His reaſon for this conjecture is founded upon the following experiment: upon burning ſea-wreck to a black coal and ſtopping the proceſs at that point, he has obtained great plenty of common ſalt, but no mineral alkali from the black aſhes; though we are certain, that when the black aſhes are thoroughly calcined, or reduced to white aſhes, mineral alkali may be obtained from them. This makes it probable, that the common ſalt contained in the black aſhes of ſea-wreck is decompoſed, and changed into a mineral alkali, during the burning of the black aſhes. There are reaſons to ſuppoſe, that the cinder of pit-coal would anſwer the purpoſe better than charcoal. *Chem. Eſſ.* vol. i. p. 136, &c.

Potaſh.

10 Dr Home's experiments on the pot-aſhes of different countries.

The potaſhes of different countries vary much in quality; and the experiments of Dr Home, in his treatiſe on Bleaching, ſeem to ſet forth their different properties in the cleareſt point of view. The different kinds tried by him were,

1. *Blue pearl-aſhes.* Theſe appear to be a pure alkaline ſalt, mixed with a ſmall quantity of vitriolated tartar and earth. Half a pound of this, filtered and evaporated, yielded $5\frac{1}{2}$ ounces of pure ſalt.—Here, however, we muſt obſerve, that though the quantity was ſo far diminiſhed by this operation, yet we are not to imagine that the whole of this diminution was owing to impurities; for all ſalts are deſtroyed in ſome meaſure by ſolution in water and exſiccation.

2. *White pearl-aſhes* are nearly of the ſame quality with the former; half a pound of them giving five ounces and ſeven drams of pure ſalt, with ſome vitriolated tartar and earth.

3. *Ruſſia* or *Muſcovy aſhes* have very much the appearance of ſlacked lime, and are, like it, friable betwixt the fingers. They adhere to the tongue; and their alkaline taſte ſoon goes away, leaving in the mouth a ſtrong taſte of lime. Some ſmall bits of charcoal are obſervable in their compoſition, and they never turn moiſt in the air. Half a pound of the ſalt lixiviated with water and evaporated, gave only 10 drams 15 grains of very cauſtic ſalt. Theſe conſiſt therefore of a ſmall quantity of alkaline ſalt united with a large quantity of lime.

4. *Caſhub-aſhes* are of the colour of iron ſtone, and extremely hard, with many ſhining particles of charcoal in them. They have a ſaline taſte, with a conſiderable degree of pungency; feel gritty in the mouth when broke in pieces by the teeth; and will diſſolve in water. To extract the pure ſalt, half a pound of the aſhes were boiled in a pint of water; then that water poured off, and half a pint put on the aſhes again; and ſo on, till the aſhes taſted no more ſalt. This boiling took 24 hours, and the laſt water that came off had a ſtrong taſte of ſulphur, and was blackiſh. A piece of ſilver put in the decoction was in a few minutes turned almoſt black; but though the decoction was evaporated conſiderably, it did not turn ſilver black more ſpeedily than before. The whole, when totally evaporated, yielded only 10 drams of a brown ſalt having a ſtrong cauſtic alkaline taſte. Some Caſhub-aſhes powdered, and often waſhed in water ſo that the ſalts were all carried off, were infuſed in water. After ſtanding ſome time, there was a weak lime-water, with ſomething of a ſaline taſte, but no pellicle. Some of this reſiduum was put into a reverberatory furnace for two hours; after which it afforded good lime-water. Caſhub-aſhes then appear to contain an earth half vitrified, ſome lime, alkaline ſalts, and a quantity of ſulphur.

5. *Marcoſt aſhes* are of a paler colour than the former, with ſome ſmall pieces of charcoal in their compoſition. They have a ſtrong ſaline taſte; and ſo great pungency, that they cannot be held long in the mouth. Half a pound diſſolved in water, filtered and evaporated, yielded 11 drams one ſcruple and two grains of alkaline

Potash.

kaline residuum. The decoction blackened silver, but not so strongly as the former; and by evaporation it quickly lost that quality.

11 On manufacturing them in this country.

Our author next proceeds to consider the probability of manufacturing these ashes in this country. On which subject he has the following observations.——"The blue and white pearl-ashes we have discovered to be pure alkaline salts, without any considerable mixture of heterogeneous bodies. Their purity shows the lixive to have been strained through some close substance, such as linen or flannel. The blue ashes show by their colour that they have sustained the most fire. But both of them are so much alike, that the one may be substituted for the other; and therefore we shall consider them in one view.

"Every one knows that alkaline salts, such as these, are got from all plants except the alkalescent, and from all trees except the most resinous, which afford them in very small quantity. These plants or trees, when found, are pulled or felled in the spring, dried, and burnt to ashes. By the affusion of warm water the salts are dissolved, and, by straining, separated from the earth along with the water. This saline liquor, which is called a *lixive*, is evaporated over a fire; and what remains is an alkaline salt of the same kind with the pearl-ashes.

"I was informed by a skilful bleacher in Ireland, that he practised a more expeditious way of extracting the salts. He bought the ashes of different vegetables from the commonalty for 9 s. a bushel. From these a very strong lye was made, into which dry straw was dipped until it sucked up all the lye. This straw was afterwards dried and burnt, and gave him salts which he showed me, almost as good and pure as the pearl-ashes. This method I have several times tried; but could never burn the straw to white ashes, the salts diminishing the inflammability of the straw. It is a very expeditious method if it can be practised. But I can see no occasion for bringing the lye into a solid form, as the salts must again be dissolved in water before they can be used. The strength of the lye can easily be determined by the hydrostatical balance.

"Though I make no question, that the quantity of salt, in plants of the same species, will vary in different soils and climates; yet it would be of advantage to have the proportion ascertained in general. Some trials of this kind I have made.

"Two pounds of fern which had been pulled August 16. were dried, and burnt to white ashes. These weighed 7 dr. and tasted very salt. When lixiviated, strained, and evaporated, they gave me 49 gr. of salt, about the eighth part of the ashes. If the fern had been pulled in April, it would have afforded more salt. Why then should we not prepare salts from this vegetable? There is more of it growing on our hills than would serve all our bleachfields. The Irish make great use of it.

"From 11 oz. of tobacco-ashes I had 1 oz. of salt. Two ounces of peat-ashes afforded half a drachm of salt. Nettles, I am informed, afford much salt. Furz and broom, natives of this country, are very fit for this purpose.

"But the kelp, as it grows in such plenty along our shore, and contains more salt than any other vegetable I know, would be the most proper, were it not for a mixture of some substance that renders it unfit for bleaching, at least of fine cloths, after they have obtained a tolerable degree of whiteness. It is observed by bleachers, that, in these circumstances, it leaves a great yellowness in the linen. As these ashes are much used in Ireland, and as it is not uncommon to bleach coarse cloths with them in Scotland, a disquisition into their nature, and some attempts to purify them, may not be improper. There are no ashes sold so cheap as these; for the best gives but 2 l. the 2000 weight (B). They may, therefore, allow of more labour to be expended on them, and come cheaper at long-run than the foreign salts.

"I dried some sea-ware, and burnt it, though I found that last operation very difficult. When I had kept it fused in the fire for two hours, it weighed $3\frac{1}{2}$ oz. I poured on the ashes an English pint and a half of cold water, that I might have as little of the sulphur as possible. This lye, after it had stood for some hours, was poured off clear, and had but a slight tendency to a green colour. I made a second infusion with milk-warm water, and poured it off from the sediment. This had a darker colour than the former; was kept separated from it, and evaporated by itself. There was a third infusion made; but having no salt taste, it was thrown away. The second infusion seemed to contain more sulphur than the first; and a piece of white linen kept in it half an hour, while it was boiling, was tinged yellow, and could not be washed white again. The earthy part remaining, weighed, when well dried, 1 oz. 2 dr. The saline decoction evaporated by degrees, and set at different times in a cellar to crystallize, afforded me 5 dr. 46 gr. The liquor, when entirely evaporated, left $4\frac{1}{2}$ dr. of a yellow salt, which appeared to be a strong alkaline. The salts which crystallized seemed to be mostly sea-salt, with a considerable quantity of sulphur, and some alkaline salt. There appeared no signs of the bittern in these salts, as their solution did not turn turbid with the oil of tartar. Nor is any of the bittern to be expected in kelp ashes, although it probably is to be found in the recent vegetable; because the alkaline salts formed by the fire must have changed it into a neutral. The lye made warm with water, being evaporated, left 4 dr. of a black bitter salt, which, from its quantity of sulphur, appeared unfit for bleaching. These ashes, then, seem to be a composition of somewhat less than the fourth of sulphur, the same quantity of sea-salt, about a fourth of alkaline salt, and somewhat more than a fourth of earth. The alkaline salt contained in kelp ashes amounts to one penny a pound. This cheapness makes it worth our pains to bestow some labour on them.

"If the bad effects in bleaching with kelp-ashes arise from

6

(B) "Since this treatise was written, however, the price of kelp has been advanced to 7 l. or upwards the 2000 weight; so that those who would now attempt any thing of this kind, must also manufacture the kelp themselves."

from the sea-salt, as some of the most knowing bleachers think, they can be freed from it in an easy manner. Let a lixive of kelp-ashes be made with cold water, for that does not extract so much of the sulphur; it must stand but for a short time, for these salts dissolve easily; decant it, and evaporate the lye. As the boiling continues, the sea-salt will crystallize. When that is all separated, the remaining lye will contain alkaline salt with some sulphur. This operation every master of a bleachfield may learn and oversee, without taking up much of his time. A similar process is carried on by common servants in the alum-works, who have by practice learned it from others.

"I had some hopes that the sulphur might be carried off by long roasting, such as these salts undergo before they are fused in order to be turned into glass; because I had observed, that the longer time they were kept in the fire, the freer were they from this sulphureous part.

"I ordered a quantity of kelp ashes to be kept in the furnace of a glasshouse, where the heat was just below the vitrifying point, for 24 hours. During this time they had lost almost four-fifths of their weight. They were now much freer from their sulphur, and were of a light colour; but much of the alkaline salt had been driven off with the oils. If a lye is much impregnated with this sulphureous matter, it appears to be carried off in a great measure by long boiling.

"We come now to explain the method of manufacturing the white Muscovy ashes. We have shown, by undoubted experiments, that the greatest part of these ashes consists of lime; and yet we have several acts of parliament which forbid the use of that material under severe penalties. The parliament were in the right to discharge its use, upon the disadvantageous reports which were made to them. We shall immediately see how dangerous a material it is when used improperly, or without the mixture of alkaline salts, which render it safe, and more soluble in water. But I will venture to say, that experiment will not support the prejudice entertained with regard to it, if carried any further.

"Since bleaching, then, cannot be carried on without it (for those ashes which contain it are quite necessary in that operation), and since we import them from foreign countries, let these prejudices against it cease, and let us only consider how we may render our own lime as safe as the foreign. If we can do that, the wisdom of the legislature will be as ready to abrogate these acts as they were to make them.

"By my experiments on the white Muscovy ashes, I got about the eighth part of alkaline salts from them. This made me expect, that, by mixing in the same proportion quicklime and alkaline salts, I should be able to produce Muscovy ashes.

"To an ounce of quicklime and a drachm of white pearl ashes, I added about a gill of water, and boiled them together till the water was all evaporated. The taste of this substance was little different from lime. To recover the salts again from the lime, I dissolved it in water, strained off the liquor, and evaporated it. Instead of the drachm of salts, I had but 2 gr. of a substance which was more earthy than saline.

"To 3 dr. of quicklime, and as much potashes, I added a mutchkin of water, and kept it boiling for two hours till it was evaporated. I dissolved it again in water, which being filtered and evaporated, gave me $1\frac{1}{2}$ dr. of a caustic salt, that liquefied in the air when it had been but four minutes from the fire. It appears, then, that the alkaline salts are destroyed by lime, and that a great part of them can never be again recovered. From the remaining lime, after the salts were extracted, I got strong lime-water, but without a pellicle. This shows, that a quantity of alkaline salts, equal to the lime, boiled with it for two hours, are not able to fix all the soluble part of the lime.

"From these experiments we may draw some corollaries with regard to the present subject. *1st*, That evaporating the water from the lime and salts by boiling, is a most unfrugal way of preparing these white ashes. *2dly*, That these ashes ought to be kept close shut up in casks; for if exposed to the open air, though in a room, the alternate moisture and drought must fix their most useful parts. This I have found to be fact: for the salts that I made became less pungent by keeping; and I have observed, that the surface of the Muscovy ashes lost all pungency by being exposed to the air, while their internal parts still retained it. *3dly*, That all boiling is prejudicial to these Muscovy ashes, as it fixes, and that quickly, their most subtile and probably their most serviceable parts.

"Let us now proceed to another method of making these white ashes. I imagined, that if the salts were dissolved in water, and the quicklime slacked with that, the mass would soon dry without the assistance of fire. In this way I added equal parts of both; but the composition was so strong, that it blistered my tongue if it but touched it. When the fourth part was alkaline salt, it blistered my tongue when kept to it a few seconds. I could taste the salts plainly in the composition, when they made but the thirty-second part of the whole.

"I thought, when composed with the eighteenth part of salt, it had, when fresh made, just the taste and look of the Muscovy ashes; nor could any person have distinguished them. This I once imagined was the proportion; but when I found that the saline pungency soon turned weaker by keeping, and that this composition would not afford the same quantity of salts that the Muscovy ashes did, I saw that a much greater quantity of salts was necessary. The proportion appears to be one of salt to four of lime, prepared in this last way. Three drachms of ashes prepared in this way, and kept for a fortnight, gave me but 15 grains of salt; which is but the half of what the Muscovy would have afforded. I find, if the quicklime is first quenched, it does not fix the salts so much; and therefore is better and cheaper. One drachm of potashes dissolved in a little water, and added to 3 drachms of quenched lime, gave me 44 grains of a very caustic salt. I prefer this method as the best.

"The manufacturers of this salt probably pour the lixive upon the lime, as they can know by its specific gravity what quantity of salts is in the water, and so save themselves the expence of procuring the salts in a dry form.

"The manufacture of the Marcost and Cashub ashes remains yet to be explained. We have discovered that both of them contain sulphur, earth, alkaline salts, and lime;

Potash.

lime; and differ in nothing but in the Cashub's having more sulphur than the Marcoft ashes. We shall therefore consider them together.

"Whether these two species of ashes are of any use in bleaching, may be, and has already been, disputed. I find they contain no other principles, the sulphureous part excepted, than the former ashes combined together. Why then should we expect any other effects from the same ingredients in the Marcoft and Cashub ashes, than what we have from either of the pearl and Muscovy ashes mixed together? The sulphureous principle in the former must have very bad effects; as I find by experiment, that it leaves a yellowness on cloth that is very hard to be washed out. It is owing to this sulphureous principle that linen, after it has been washed with soap, and is pretty well advanced in whiteness, is apt to be discoloured by lye which is brought to boil: for, by boiling, the sulphureous part is extracted from these ashes, and the lye becomes of a deep brown colour. Daily practice, then, shows the disadvantage of this sulphureous principle. Besides, as sulphur unites itself quickly and firmly with alkaline salts, it must weaken or altogether destroy a great quantity of these in the Marcoft and Cashub ashes, and so render them of no effect in bleaching. These two reasons seem to me sufficient to exclude them from the bleachfield; especially as, by increasing the other materials, we can attain perhaps more speedily the same end.

"However, as custom has introduced them into general practice, we shall consider how they are to be manufactured. Dr Mitchell has, in a very ingenious and useful paper, contained in the Philosophical Transactions for the year 1748, delivered an account transmitted to him by Dr Linnæus of the method of making potashes in Sweden. This account was contained in an academical dissertation of one Lundmark upon this subject at Aboe in Sweden. The substance of this account is, 'That birch or alder is burnt by a slow fire to ashes, and made into a paste with water. This paste is plastered over a row of green pine or fir logs. Above that is laid transversely another row of the same; and that likewise is plastered over. In this way they continue building and plastering till the pile be of a considerable height. This pile is set on fire; and whenever the ashes begin to run, it is overturned, and the melted ashes are beat with flexible sticks, so that the ashes incrust the logs of wood, and become as hard as stone.' This, in the Doctor's opinion, is the method of making the potashes that come from Sweden, Russia, and Dantzic: and that there is no other difference betwixt the ashes made in those different countries, but that the Russian, containing more salt, must be made into a paste with a strong lye.

"There would appear, by my experiments, a greater difference than this betwixt the Swedish ashes, if that is the true process, and those I have examined. I had discovered the greatest part of the Muscovy ashes to be lime. I suspected it might enter into the composition of the Marcoft and Cashub; and have accordingly discovered it there. Without the same grounds, none would ever have searched for it. Whence then comes this lime? It must either enter into its composition, or arise from the materials managed according as the process directs.

"I have tried the birch ashes made into a paste with water. I have tried common charcoal made into a paste with a third part of potashes, and kept them in a strong reverberatory heat for some hours, and yet no such caustic substance appeared. I have kept earth and salts of kelp-ashes fused together for 24 hours in the furnace of a glasshouse, where the heat was just below the degree of vitrification; and yet no remarkable causticity appeared afterwards in the concreted mass. But supposing that there did, will ever this account for the generation of lime? These chemists do not assert that it is a calcareous causticity. The earth of vegetables kept in fusion with their salts, is so far from turning into a quicklime, that the mass takes the opposite course, and becomes glass. Bodies that, by the laws of nature, are vitrescible, can never, so far as we know, become calcareous. In one or other of these two substances all bodies terminate that are changeable by fire; and vegetables are of the former kind. Here it may be asked, Why then, since they endure such a fire, are they not vitrified? the objection would be just, did they contain nothing else but what was found in vegetables. But if we once allow that lime is one of the materials, the difficulty is easily solved: for lime, we know, in proportion as it is mixed, hinders the vitrification of all bodies. In effect, the earthy part in these ashes is almost vitrified: and I think that I have carried the vitrification yet farther in that part; but I never was able, with the utmost heat of a reverberatory furnace, continued for six hours, to produce any thing like a thorough vitrification in these ashes. The heat of the fire used in the process would seem to be very great; and must, if it were not very difficult, reduce them to glass. The invitrescible nature of these salts, so far from being an objection, becomes a strong proof of my opinion.

"These salts have a remarkable pungency. This we have already seen is the natural effect of quicklime on salts.

"These salts are found to be the fittest for making soap, and to incorporate soonest and best with oils. Salts, we know, of themselves do not readily unite with oil; but when once mixed with quicklime, they have a greater tendency to union.

"Again, I find that these ashes are more easily fluxed than charcoal made into a paste with the third part salt; which is much more than the ashes contain. Now, it is observed that quicklime increases the fluxing power of alkaline salts; for the common caustic made of quicklime and alkaline salts is sooner fused than the latter alone.

"From these reasons, and the experiments that discover lime in these ashes, I am led to think, that it is not generated by the process, but mixed with the ashes when they are made into a paste. The following experiment is a convincing proof of what I have been endeavouring to make out.

"I boiled some pease-straw in a strong lye of pearl-ashes burnt into a black coal, and made it into a paste with water. Another quantity of straw was boiled in a lye made of one part of quicklime and four parts of pearl salts, the lye being poured off turbid from the lime. This straw was likewise burnt when dry, and made into a paste. These two substances were put in-

 to

otaſh. to ſeparate crucibles, and fluxed in a reverberatory furnace. The latter appeared to reſemble the Marcoft and Caſhub aſhes more than the former, which ſeemed to want their pungency."

12 aſhes Pearl- es ob ed from tral s.

Though the only method of preparing the alkaline ſalt originally is by the combuſtion of vegetables, yet there are ſome neutral ſalts from which if it were poſſible to expel the acid, we ſhould have it in our power to procure the fineſt pearl-aſhes in vaſt quantity. Theſe are vitriolated tartar, nitre, but eſpecially ſea-ſalt, on account of the inexhauſtible quantities of it to be met with in the waters of the ocean. Unhappily, however, there are ſome objections to every one of thoſe. The vitriolated tartar, or any other ſalt in which the vitriolic acid enters, cannot be decompoſed without converting the acid into ſulphur by charcoal-duſt; in which caſe it is as difficult to get free of the ſulphur as of the acid; and if we attempt it by frequent ſolutions in water, we deſtroy the phlogiſton of the ſulphur, and have only vitriolated tartar again inſtead of alkali. See Chemistry, n° 716, &c.

With reſpect to nitre, though its acid may be expelled by fire, yet it is too high-priced, and too much uſed in other manufactures, to be thought of for this purpoſe. A potaſh manufacture from ſea-ſalt has indeed been lately erected in England. The principle on which this was eſtabliſhed is, that the acid of ſea-ſalt may be extracted by means of lime; and accordingly we find that the ſaline efloreſcence, which frequently appears on walls, conſiſts chiefly of the marine alkali deprived of its acid. But this, though delivered on the credit of a very eminent chemiſt, we can affirm from our own obſervation to be a miſtake. Of the many caſes in which we have examined this efloreſcence, only one was found to be alkaline; the others uniformly appeared to be true Glauber's ſalt compoſed of the vitriolic acid and foſſil alkali. Neither did this appear to be formed by any decompoſition of ſalt originally in the plaſter, but to be a real generation of both acid and alkali where none of them exiſted before. See Efflorescence.

POTATO, in botany. See Solanum.

1 w potas were roduced o Britn.

Potatoes, it is generally thought, came originally from North America, where they were not reckoned good for food. They were firſt (we are told) introduced into Ireland in the year 1565, and from thence into England by a veſſel wrecked on the weſtern coaſt, called *North Meols*, in Lancaſhire, a place and ſoil even now famous for producing this vegetable in great perfection. It was 40 years after their introduction, however, before they were much cultivated about London; and then they were conſidered as rarities, without any conception of the utility that might ariſe from bringing them into common uſe. At this time they were diſtinguiſhed from the Spaniſh by the name of *Virginia potatoes*, or *battatas*, which is the Indian name of the Spaniſh * ſort. At a meeting of the Royal Society, March 18th, 1662-3, a letter was read from Mr Buckland, a Somerſet gentleman, recommending the planting of potatoes in all parts of the kingdom to prevent famine. This was referred to a committee; and, in conſequence of their report, Mr Buckland had the thanks of the ſociety, ſuch members as had lands were intreated to plant them, and Mr Evelyn was deſired to mention the propoſals at the cloſe of his Sylva.

* See Convolvulus, 5.

Potato.

2 Their late introduction into Sweden.

In Sweden, notwithſtanding the indefatigable induſtry of Linnæus, the culture of potatoes was only introduced in 1764, when a royal edict was publiſhed to encourage their general cultivation. They were known there, however, at an earlier period; for in *the Memoirs of the Royal Academy of Sciences in Sweden*, 1747, M. Charles Skytſe propoſed to diſtil brandy from them, in order to ſave corn, which in that country is very dear. He found by experience, that an acre of land ſet with potatoes will yield a much greater quantity of brandy than when ſown with barley.

3 Their great utility.

The utility of potatoes to the common people is well known, and this utility has brought them into general uſe, and has extended them over every part of this kingdom. To promote this utility, and to make their cultivation more eaſy, a variety of experiments and inquiries have been made. Some of theſe we ſhall now lay before our readers, without repeating, however, what has been ſaid on the ſame ſubject in the article Agriculture, n° 158—167.

4 Remarks and experiments on their culture.

By many people the Iriſh purple potato is thought to be the ſweeteſt and beſt; and of theſe the bright and middle-ſized are directed to be ſet whole, in February, March, and April, in a fine deep tilth, in any ſoil. During the froſt, the firſt ſetting ſhould be covered with litter or fern. They ſhould be ſet ſix inches deep, and a yard diſtant from each other every way, in a kind of hillocks like a mole-caſt; and they muſt be moulded every month or fortnight, as high as poſſible. By July or Auguſt, under each hillock there will be nearly a buſhel of potatoes. The white kidney potato runs all into ſtringy roots in looſe ground, while the pink-coloured will do extremely well in the way we have now directed; and the ſmalleſt of them, though often given to hogs, unleſs they be otherwiſe improper or unhealthy, will be very good ſeed.

The following experiments concerning the culture of potatoes are related in the Georgical Eſſays.

5 Of the Howard potato.

"By all the experiments that have been made, the Howard or large Bedfordſhire potato is found to produce the largeſt crop. On that account they are chiefly uſed in feeding of cattle. In two beds, four feet wide, and 200 feet long, I planted in a common field a ſufficient number of ſets of this kind of potato, and managed them by a horſe-hoe. The produce was 64 buſhels, each buſhel up-heaped, weighing about 70 lb. My cattle eat them boiled with as much eagerneſs as the beſt ſorts, and came on as well with them. I have built a boiling-houſe, &c. on Mr Young's plan, and during this whole winter have boiled potatoes for my cattle. For the fattening ones, I mix ground oats with them; and for the milk-cows, malt-duſt; and dare venture to affirm, that they are much more profitable than either turnips or cabbages. Once, when my potatoes grew low, I deſiſted giving them to the milking-cows. Immediately, though fed with the beſt hay, they fell off amazingly in their milk. I therefore began again; and in a week's time they gave better than one-third more butter. I own this accidental diſcovery gave me much ſatisfaction, as it confirmed my opinion, that potatoes boiled are an excellent winter food for cattle. Their culture is not ſo difficult, at leaſt not ſo precarious, as either turnips or cabbages. Their value is ſuperior, and there is no riſk of their giving a diſagreeable taſte either to butter or

 milk.

Potato. milk. Add to this the vaſt increaſe of the Howard potato, and its equality with the beſt ſorts when uſed for cattle.

6 Of the increaſe of potatoes.

" My gardener cut a large potato into nine pieces, which he planted with dung, in a drill, in the garden. By earthing up and laying the ſhoots, he produced 575 (A) ſizeable potatoes, which weighed eight ſtone eight pound. Another of my ſervants produced, in the field, ſeven ſtone of good potatoes from the ſame number of ſets. Though this experiment cannot always be executed in its full force in an extenſive ſcale, it ought, notwithſtanding, to be imitated as nearly as circumſtances will allow. It ſhows, in the moſt diſtinguiſhing manner, the uſe of clean and careful huſbandry.

" On the 14th of April, I cut a large white potato into 17 ſets, which were planted in as many hillocks, at the diſtance of four feet. In the courſe of growing, the plants were earthed up, and on the 14th of October the crop was taken up: The produce, 10 pecks of ſizeable potatoes. At the time that this experiment was made, I had ſeveral hillocks, in which I put three and four ſets of the ſame kind of potato. But, upon the moſt careful examination, I could not obſerve that theſe hillocks produced a greater crop than the others planted with a ſingle ſet. Hence it is obvious, that the potato ſpreads its roots moſt kindly when leaſt crowded."

Whilſt ſpeaking of the increaſe of potatoes, we cannot help taking notice of a memoir by John Howard, Eſq; of Cardington, in Bedfordſhire, on a new kind of potato remarkable for its prolificacy. " In the year 1765 (ſays he) being at Clifton, near Briſtol, I was informed a perſon had brought from America a new ſort of potato, and with ſome trouble I procured half a dozen roots of it, as the greateſt part of thoſe brought over were already planted. That autumn I planted three of them, and in the following ſpring the other three, in my garden at Cardington in Bedfordſhire; ſetting them in hillocks about ſix feet aſunder. The ſtrength of the ſtems, and largeneſs of the bloſſom and apples, gave the pleaſing proſpect of great increaſe: and accordingly, when I took them up in the autumn 1766, I found they had increaſed far beyond any of the common ſort, which for ſome years I had encouraged our cottagers to cultivate. The produce from each cutting was in weight from 26 to 27 pounds and a half. I ſent for two of the Bedford gardeners, who ſerve the market, to ſee them taken up, and they were ſurpriſed at the great increaſe. I gave ſome of them to theſe gardeners, and others to almoſt all our own cottagers. The increaſe continued to appear the ſame in the ſucceeding year, viz. 1767, as in the laſt: only, as many of the ſingle potatoes had been then found to weigh four or five pounds each, I had now planted moſt of them in drills three feet aſunder, in order to procure a greater number, and a leſs ſize. Their produce was now from 22 to 30 pounds from each cutting; and the potatoes were more ſizeable for common uſe. The vegetation was not ſo luxuriant as in thoſe I before planted in hillocks; but the increaſe of theſe was, allowing the cuttings to weigh one ounce, full 400-fold. Having laſt year upwards of a waggon-load of theſe potatoes, I with pleaſure ordered it to be made publicly known, that every perſon who choſe to cultivate them were welcome to have a quantity for planting. In conſequence of this, numbers applied in our own and the adjacent counties. In my plantations, as well as thoſe of other perſons, the increaſe has been ſtill greater this year: for the ſeaſon having proved very favourable, I have had from ſome hillocks 41 pounds and a half, allowing for dirt."

We now continue our extracts from the Georgical Eſſays.

7 On raiſing potatoes from ſeed.

" Take a bunch of the apples of any ſort of potato. Hang it up in a warm room during the winter, and in February ſeparate the ſeeds from the pulp, by waſhing the apples in water, and preſſing them with the fingers. Then dry the ſeeds upon paper. In the month of April, ſow theſe ſeeds, in drills, in a bed of earth well dug, and manured with rotten dung. When the plants are about an inch high, draw a little earth up to them with a hoe, in order to lengthen their main roots. When they are about three inches high, dig them up with a ſpade, and ſeparate them carefully from each other, in order for planting out in the following manner. Prepare a piece of freſh ground by trenching it well. Dig up the ſeedling plants as before directed; and plant them out in the ground, thus prepared, in ſuch a manner that there ſhall be 16 inches between each plant. As they advance in growth, let them receive one or two earthings up, in order to lengthen the main root, and encourage the ſhoots under ground. By this management, the potatoes will, in the courſe of one ſeaſon, arrive at the ſize of hen's eggs, and the haulm will be as vigorous as if ſets had been planted. But what proves the luxuriancy in the moſt convincing manner, is, that flowers and apples are produced.

" In Lancaſhire, where the gardeners raiſe potatoes from ſeed, they are always two, and ſometimes three, years in bringing them to full ſize. By the above method of tranſplanting, with wide diſtances, many of the potatoes nearly attain their full ſize in one ſeaſon. It is obſervable, that theſe ſeedlings produce potatoes of all the different kinds; and ſometimes new ſorts are procured. We do not find any difference whether the apple comes from one kind or another. It is not ſo when we uſe the ſet, which invariably produces the ſame kind. Potatoes, when propagated from ſets, after a number of years, are found to decreaſe in bearing; for which reaſon they ſhould be brought back every 14 years to their original. From a want of attention to this circumſtance, I have known potatoes ſo run out, that they hardly returned treble ſeed. The farmer complains that his land is tired of them; but the true cauſe

(A) Inſtances of the amazing increaſe of potatoes are very numerous, and are almoſt every year detailed in the public papers. In the Gentleman's Magazine for 1757, p. 480, we are told, that from one ſlice of a potato, ſet in the ſpring of the ſame year by Mr Simon M'Hoy, a farmer at Park near Tuam in Ireland, there proceeded no leſs than 84 ſtalks, which produced 965 potatoes.

[Po]tato.

cauſe is the age of the ſets. The increaſe of potatoes raiſed from ſeed is aſtoniſhing. They continue in vigour for about 14 years; after which the produce gradually declines.

8 [R]aiſing [ea]rly pota[toes].

" As the culture of potatoes, and particularly of the early ſorts for the table, has of late become an object of very general attention, I hope the following account of a new method of obtaining theſe (without the help of hot-beds) will be acceptable to the public.

" On the 2d of January 1772, I made a hot-bed for the forward ſort of potatoes, and on the 7th put in the ſets, placing a glaſs and frame over them, and taking every precaution to defend them from the froſt. Of theſe ſmall potatoes, or ſets, there remained about 40 in a baſket, which was accidentally hung up in a warm kitchen, and there remained unnoticed till about the 25th of April. I then accidentally obſerved the baſket, and perceiving ſomething green on the edge of it, took it down, and, to my great ſurpriſe, found that the potatoes had ſprouted half a yard in length, and that there were a great number of very ſmall potatoes formed on the fibrous roots which had grown out. I took them into my garden, and planted them in a rich ſandy ſoil, without any manure. The roots I put into the ground three inches deep, and laid down the ſtems that had ſprouted, horizontally, and covered them with two inches of ſoil, but left the tops uncovered. Without farther attention they grew ſurpriſingly.

" On the 26th of May, I took up the roots planted in the hot-bed on the 7th of January. They by no means anſwered my expectations, or paid for the trouble of their culture: but, at the ſame time, I was aſtoniſhed to find the others, which were put into the ground ſo late, to have produced larger potatoes than the roots in the hot-bed. I took up all the roots, and picked off the large potatoes from them, which amounted to from 4 to 12 on each root, and then ſet the roots again in the ſame ground. This, indeed, I have ſucceſsfully practiſed for many years, ſometimes even twice, and have had a third good crop at Michaelmas. When this method is tried, the roots muſt be watered on the evenings of hot days.

" In January 1773, in order to make a ſecond trial of this experiment with a large quantity, I placed a great many potatoes of the early ſorts on a thick layer of gravelly ſoil, cloſe to each other, over an oven, flated over, but open to the ſouth-weſt, and covered them two inches deep with the ſame earth. At the end of April I took them up, and found the ſtems about a foot long or more. For fear of injuring the fine and delicate fibres of the roots, I took great care in taking them up, and planting them in the ſoil. This I now manured, but in all other reſpects treated them in the manner above deſcribed; many of the fibrous roots having then potatoes formed upon them nearly as large as walnuts. For a week, the plants came on ſurpriſingly, when, by one ſharp night's uncommon froſt, they were nearly deſtroyed. However, notwithſtanding this, freſh ſtems grew up in a few days, and I actually gathered from them, on the 3d of June following, finer potatoes than were ſold at that time, at Mancheſter, from 1 s. to 1 s. 6 d. per pound, being the produce of hot-beds. After taking off the larger potatoes, I again planted the roots for a ſecond crop, and in September obtained a very large produce. I weighed the increaſe of many ſeparate roots, which amounted from four pound eight ounces to 14 pound 12 ounces, the potatoes being the largeſt of the forward kinds I ever ſaw.

Potato.

9 On raiſing them in winter.

" Make a compoſt of earth, ſand, and coal-aſhes. With this mixture fill a tub about 16 inches deep. Plant this artificial ſoil with ſome ſets of the early round potato, and place the tub in a ſtable oppoſite to a window, taking care to water the earth now and then. In all ſeaſons the ſets will ſprout, and give a tolerable increaſe of potatoes. Laſt November I planted ſome ſets in the above manner; and in February following I took up a conſiderable number of young potatoes, clean ſkinned and well flavoured.

10 On tranſplanting potato tops.

" On the 18th of May 1772, finding ſome beds I had ſown very early with onions, to be a miſſing crop, I was induced to make the following experiment. The year before, I had ſet ſome potatoes in another part of my garden in the common way; and as it is impoſſible but ſome will remain in the ground all winter, ſo I found a number of ſprouts about three inches high, which I nipped off cloſe to the ground, and tranſplanted them into the onion-beds, without any further preparation, about a foot and a half aſunder, in the ſame manner that cabbages and cauliflowers are planted. As the ſeaſon became immediately very dry, I was obliged to give my plants a little water for four or five ſucceſſive nights; after which they began to flouriſh, and had the appearance of a promiſing crop during all the ſummer. At the uſual time, in October, I ordered them to be taken up; and for ſize, quantity, and quality, they exceeded all I ever had in the common way. Had the ground been freſh, properly manured and prepared, and the plants put down at a proper diſtance from each other, I am of opinion that the ſucceſs would have been ſtill greater.

11 On feeding hogs, &c. with potatoes.

" From an accurate experiment made laſt year, I dare venture to recommend baked potatoes as an excellent food for hogs. The pork produced by this food was equal to that from barley and beans: but at preſent I cannot exactly aſcertain the comparative experiment with regard to expence; however, I am of opinion, that roaſted potatoes, conſidering the improvement of the hogs, is as cheap a food, if not cheaper, than can be given them. I roaſted my potatoes upon a kiln, ſimilar to what is uſed by oatmeal ſhellers for drying their oats. The difference in expence between boiling and roaſting the potatoes is prodigious, both with regard to the labour and fuel. A kiln that will coſt 3 l. will roaſt potatoes ſufficient for the maintenance of more than 20 hogs; and one man will beſtow all the neceſſary attendance upon them, and do other work beſides. The action of the fire, by diſſipating the crude juices that are contained in raw potatoes, reduces them into a ſtate highly wholeſome and nutritious. Boiling does this in part, but not ſo effectually. A potato roaſted in the manner above deſcribed, partakes much of the nature of a cheſnut, and perhaps is not greatly inferior to it."

Potatoes are found to be uſeful food for moſt other animals. See Agriculture, n° 45.

To theſe experiments we ſhall add ſome important obſervations of Dr Anderſon of Coteſield near Leith, who

Potato.

12
Remarks on the seeds most proper to be planted.

who has paid a very particular attention to this as well as other branches of agriculture. Our readers will find the Doctor's remarks and experiments at large in the *Bath Papers*, volume fourth. He first considers the nature of the seeds most proper to be planted; and from his experiments he thinks it appears that the produce is not materially affected, by planting for seed, either whole potatoes or cuttings, or large or small potatoes as such; for it is only incidentally that these things can affect the crop. In the fifth volume of the *Bath Papers*, Mr Wimpey relates an experiment, by which it would appear that there is an advantage in planting cut potatoes. His conclusion is as follows. "The measure of all the ground planted, says he, was 325 poles; the whole produce 378 bushels. The measure of the ground planted with cut potatoes was 265 poles; the produce 312 bushels. The ground planted with whole or uncut sets was 60 poles, and the produce of the same 66 bushels. Now, if 48 bushels, the whole quantity of sets used, produced 378 bushels, then 34 bushels, the quantity cut, should produce 267 bushels; but they produced 312, which is 45 bushels more than the proportion. Again, if 48 bushels produced 378 bushels, then 14 bushels should have produced 110 bushels; but 14 bushels of uncut produced only 66 bushels, which is 44 bushels less than the proportion. A preference of 40 *per cent.* in favour of cut potatoes, in comparison with whole sets." Mr Wimpey corroborates the fact in the sixth volume of the same work, and informs us, moreover, that he used to supply many of his neighbours with potatoes for planting; some of whom desired to have them all small, as they had found them equally productive with the larger, and saved much trouble in cutting. "Others (continues he) preferred the largest, who carried their economy much further: they, it seems, used to pare them, eat the fleshy part, and plant the rinds only. Upon inquiry, I found it was not an unusual practice among the cottagers; and I have been credibly informed they get as large crops and as good potatoes in that method of planting as in any other whatever. If this be a fact, it seems to appear that the fleshy part of the bulb is of no use in supplying nourishment to the young fruit after the fibrous roots have put forth and laid hold of the ground. Perhaps an experiment of this sort may be thought worth making." The weight of the crop, however, Dr Anderson asserts (and Mr Wimpey agrees with him, see Bath Papers, vol. v. p. 34.), is always in some measure influenced by the weight of the seeds planted; but the weight of produce is not augmented in the *same proportion* with the weight of the seed planted; the smallest seed yielding the greatest returns in proportion to the seed, but the smallest in proportion to the extent of ground. It is in no case profitable, however, the Doctor thinks to plant small potatoes (B), or small cuttings, unless where it is meant to increase as fast as possible a favourite kind; in which case it may be sometimes eligible to plant pieces very small, as in that way the kind will be most quickly multiplied. We may also remark here, that such as wish for a large increase should never plant the worst of the crop; it is, we know, extremely common, and may indeed be an immediate saving; but it is unquestionably a loss upon the whole; and perhaps it is one cause of the *curl disease*, which is the sure indication of a poor dwindling crop, and of which we shall speak more at large immediately.

Our author further remarks, that there seems to be no reason to suspect that eyes taken from any particular part of the bulb are possessed of a degree of prolificacy greater than those taken from any other part of it, independent of the size of the fleshy part that adheres to the eye. It is however highly probable that a difference in the crop, either with respect to the number and size, or general weight of the whole, would result from planting large cuttings of equal weight, taken from the big end of large potatoes, or from the point, as many eyes would be in the last in comparison of the first. This is therefore one of the many preparatory experiments that require to be made. It is possible too that even the apples may be an object of value, and may indicate a thriving crop or otherwise; but of this there is no certainty, as no specific experiments have yet been made on this subject.

13
On cutting the stems of potatoes while growing.

With respect to the effects of cutting the stems of potatoes while growing, the Doctor seems to be doubtful. The stems of potatoes, if cut while growing, and used green, are found to be a wholesome food for cattle and horses. But though some farmers maintain that the produce in potatoes is not lessened by having the stems cut off while they are in a state of vigorous vegetation; others as positively insist that the crop is essentially injured by that operation. It is proper that this point should be ascertained. Probably the crop is hurt if the stems are cut over before they have attained a certain point of maturity, though it is possible they may be afterwards cut without doing any essential injury to it.

14
On extracting ardent spirits from potatoes.

We have already mentioned that an experiment was made a good while ago in Sweden, to extract ardent spirits from potatoes. Other experiments have been made in this country of a later date, but with little effect. This, however, appears to have proceeded either from ignorance or a want of proper attention to the fermentation and after-distillation; as appears from Dr Anderson's experiment, which succeeded extremely well by attending to these processes. What he made he asserts to have been the finest and most agreeable vinous spirit he ever saw, resembling in taste very fine brandy, but more mild, and having a certain coolness on the stomach peculiar to itself.

Much may be done in bringing potatoes to perfection

(B) In opposition to this, it is the opinion of even practical men, that the small potatoes are to be preferred. "I have been informed (says Mr Hollins) by a native of America, that what we call the long red American potato, grows in that rich and newly-cleared soil to a very large size; but that the potatoes proceeding from the roots were never used as seed; for there sprung from the stalk, very near the surface of the ground, small potatoes as they called them; but, he said, they were about the size of those raised in England, and those were always planted. I hope the Society will forgive my mentioning this, as it confirms what I have already said, 'that small potatoes are best for seed." *London Society of Arts*, vol. xi. p. 82.

tion by attending to their feveral varieties. For this purpofe fome particular potato muft be fixed upon as a ftandard; and when this is done, the inquiry muft be carried on by attending, *firft*, to their appearances below ground, as, 1. the general form and fize of the bulbs; 2. their colour; 3. the fmoothnefs or roughnefs of the fkin; 4. the confiftence, that is, the mealinefs or vifcofity and tafte of the bulb; 5. the colour, length, thicknefs, &c. of the umbilical cord; 6. their tendency to go deep, or to rife near the furface; to ramble wide, or to adhere clofe to the ftem; 7. the time when the bulbs knot and fet; marking, not by the kalendar only, but alfo compared with the advance of the plant above ground; 8. the time when they attain perfect maturity with refpect to fize, and alfo that period of their growth at which they lofe the herbaceous, and attain the farinaceous, tafte; 9. their general prolificacy; 10. how long they may be kept, at what feafon they are in greateft perfection for eating, &c. We muft *next* attend to the particulars obfervable above-ground; as, 1. the general height, colour, and form of the ftem; 2. their tendency to puſh out many or few ftems from a root; 3. whether they carry bloffom or not; 4. the form, dimenfions, and colour of the leaves; 5. the form, colour, and general habitude of the bloffom where there is any; 6. the time at which the bloffom appears; 7. the tendency they have to produce few or many apples; 8. the tendency they have to produce thofe excrefcences on the ftalks that refemble potatoes below ground, which may be called air potatoes; 9. the comparative hardnefs or tendernefs of the leaves, in refpect of froft or other variations of weather that affect them. And, *laftly*, we muft attend to the particulars that concern the whole plant; as, 1. the foil which feems beft to fuit each kind; 2. the mode of culture that beft agrees with them; 3. the accidents which are moft liable to affect them; and in general every particular that could indicate any difference between one kind and another.

16 Our author next confiders the circumftances of raifing feedling potatoes. His mode of raifing them was fimilar to that recommended in the *Georgical Effays* quoted above; but he differs with refpect to the utility or fuccefs of that mode. It has been alleged, he fays, that potatoes, which have been long propagated by means of bulbs, lofe in time their generative quality, fo as to become much lefs prolific than at firft; and it is afferted that thofe bulbs which have been lately obtained from feeds are much more prolific, and confequently much more profitable for being employed as plants than others: but this opinion appears to have been adopted without fufficient examination: for there appears not the fmalleft indication of fuperior prolificacy in thofe raifed from feeds, but rather the reverfe. That potatoes do not degenerate in point of prolificacy in confequence of being long propagated in the ufual way, feems to be confirmed by the general experience of all Europe. It is now about a hundred years fince the potato was pretty generally cultivated in Ireland, and it has been very univerfally cultivated in Britain for 50 years paft; and all that have been reared in it fince their firft introduction two hundred years ago, a very few of late only excepted, have been propagated from bulbs only; fo that if they had declined in point of prolificacy, the degeneracy fhould in this time have been very apparent. Nothing of that kind however was ever remarked, nor any infinuation of that fort thrown out, till the difcovery of rearing potatoes from feed was made, when it was for the firft time heard of. There are many perfons now living who have been in the conftant practice of rearing potatoes for 30 or 40 years; and notwithftanding the general tendency that mankind have to difpraife the prefent, when compared to paft times, yet none of them have given the fmalleft hint of degeneracy in this refpect. And perhaps it will be found that this is merely a groundlefs notion, that has originated from the partial fondnefs of thofe who firft propagated this plant from feed, in favour of their new difcovery. It has been further faid, that by raifing potatoes from feed, many new and valuable kinds may be obtained; and it is alfo afferted in the *Georgical Effays*. Indeed an opinion of obtaining new varieties of plants by propagating them from feed univerfally prevails among naturalifts. But Dr Anderfon, in his firft paper, doubts whether this be fact, and whether, when any of thefe occur, they have not been the effect of accidental pofition or other caufes. We may certainly (fays he) affert on the whole, that if the practice of rearing potatoes from feeds fhall ever be productive of any advantages to fociety, they have not yet been difcovered. Since he wrote that treatife which appears in the Bath Papers, vol. iv. (and of which we are now giving a fhort account), however, he has had occafion to alter his opinion, which he does with great candour in vol. v. The experiment which induced him to alter his opinion, and which appears to be decifive, was made with the feed of a potato procured from Ireland of a very peculiar kind. Its colour was a dirty dark purple, its fhape a round irregular bulb, and its ftem tall and upright. The feeds procured from this potato were fown by themfelves, and the feedlings when of a proper fize were tranfplanted. From the appearance of the ftems he foon difcovered that they were not all of one fort, and on taking them up the variety was almoft infinite; and fuch as could not be accounted for on the principles of a mongrel adulteration. The diverfities refpected colour, fhape, &c. fome of which he enumerates. See *Bath Papers*, vol. v. p. 127.; fee alfo p. 35. where Mr Wimpey controverts the Doctor's former opinion.

Refpecting the caufes and prevention of the *curled difeafe* in potatoes there has been a great variety of opinions, which we have detailed at fome length under the article AGRICULTURE, p. 267 to 270. Dr Anderfon confeffes that he can fay but little *pofitive* as to the caufe of this diforder, but he thinks a good deal may be faid on the *negative* fide of the queftion. It was little known till lately (c), and in the northern parts of this ifland it was abfolutely unknown but a very few years ago; and even now in the more remote corners it is ftill lefs frequent than in the more fouthern and 17

(c) In the eighth volume of the Tranfactions of the London Society for Encouragement of Arts, &c. p. 43. we are told that the curl firft appeared in 1764, in the very diftrict in Lancafhire where they were firft cultivated.

Potato. and more commercial diſtricts of the iſland. It has been ſuppoſed that nature, ſated as it were by having long produced this plant in a climate not deemed congenial to it, had become ſo far exhauſted as to occaſion this diſeaſe. But in this caſe, the more northern parts, where the climate is moſt unfavourable, ſhould have been ſooneſt affected. It has been alſo thought that potatoes, whoſe bulbs are froſt-bitten before they are houſed, occaſion this diſeaſe in the plants they produce. But the fact is, that they are leaſt liable to the diſeaſe in thoſe diſtricts where they are moſt expoſed to froſt. A potato can never indeed be benefited by froſt; but it is not at all probable that the being touched by it occaſions the curl. The taking up potatoes before they arrive at maturity has been thought to occaſion the diſeaſe; but in places where they muſt be taken up ſo, the diſeaſe is ſcarcely known. It has alſo been thought that potatoes obtained from *ſeed* are entirely free from it. But Dr Anderſon gives a proof of the contrary; for one half of the plants of a large field planted from potatoes the third year from the ſeed were curled; while another field adjoining raiſed from potatoes that never were, that he knows, produced from ſeed in this country, had ſcarcely one curled plant in the whole. The diſeaſe has been ſuppoſed by others to ariſe from the ſoil or ſeaſon. But that this is not the caſe, appears from the circumſtance of a ſingle field which Dr Anderſon planted with potatoes of the very ſame ſort, but obtained from different perſons. The ridges were intermixed, and the one was very much curled, and the other perfectly free. The diſeaſe, therefore, appears to ariſe from infected ſeed: it is however poſſible that it may be communicated by juxtapoſition; and if ſo, the diſeaſe might be in a great meaſure if not entirely avoided, by pulling out thoſe that ſhowed the leaſt ſymptom of it, on their firſt appearing above ground.

In the Tranſactions of the London Society for encouragement of arts, &c. we find a good deal about the curl diſeaſe. Many of the writers agree in opinion with Dr Anderſon in many particulars; and particularly, that though the diſeaſe may be prevented, we do not yet know enough of its nature to be able to cure it. See their vol. viii. p. 18, &c. ix. p. 52, &c. and x. p. 75. In this laſt volume we are told that the principal cauſes of the curl are three: 1. From their being forced by cultivation to overgrow their power for vegetation; 2. From their vegetative power being dried up in ebb ſoil by the ſcorching heat of the ſun; and, 3. From their being expoſed too long after they are cut in ſets before they are planted.

18 On the ſoil and ſeaſon moſt proper for potatoes.

It is generally and very naturally believed that a dry ſoil or a dry ſeaſon neceſſarily produces the drieſt potatoes. But there is good reaſon to doubt the truth of the opinion. The year 1775 was the drieſt and warmeſt ſeaſon that has been known in Scotland within the memory of man, yet the potatoes of that year's crop were watery almoſt to a proverb: on the other hand, the potatoes of crop 1777, although it was a remarkably rainy ſeaſon, were as dry and meally at leaſt as is common, and much more ſo than in the year 1775. It deſerves alſo to be remarked, that the crop of 1775 was almoſt double in quantity to that of 1777. Hence a dry ſeaſon would ſeem to augment the produce, though it does not for certain in all caſes improve the quality, of this crop; nor does a dry ſoil neceſſarily inſure meally potatoes; for our author ſays he has often ſeen potatoes of the ſame kind, and of the ſame year's produce, reared in two different places; the one of them in a naturally damp ſoil, which turned out to be much freer and more meally than the others which were reared on a drier and ſharper ſoil. He confeſſes, that he has alſo often ſeen it turn out in fact, that potatoes raiſed in thoſe diſtricts where the ſoil is hot and ſandy, are uſually more free and tender than thoſe raiſed in countries where the ſoil is cold and damp. Our author tries to account for theſe contradictory phenomena by conjecturing the probable cauſe of the waterineſs or dryneſs of a crop. He aſks, Whether in this reſpect the crop is anywiſe affected by the degree of ripeneſs that the plants employed for ſeed may have attained in the preceding ſeaſon? That this is the caſe he thinks highly probable. Potatoes which, on account of the richneſs or other peculiarity of the ſoil, continue in a ſtate of vegetation highly luxuriant till they are nipped by froſt, or checked in their growth by other inclemencies of the ſeaſon, have much leſs chance of being dry and meally than others of the ſame ſort which have attained their full growth before the coldneſs or inclemency of the weather checked them. But our author's queſtion does not relate to this, but to the effect theſe unripe potatoes, uſed as ſeed, would have on the ſucceeding crop; a circumſtance which experience alone can determine. "But even if it ſhould be found (continues our author) that the maturity of the ſeeds affected the quality of the potatoes, it would not follow invariably that the ſeeds produced on early dry ſoils would be better than thoſe from later ſoils; becauſe it might ſometimes happen from local poſition, and other accidental circumſtances, that the growth of the potatoes in the dry early ſoil might be checked by froſts many weeks before thoſe on the other ſoil were affected, in conſequence of which the plants in the cold ſoil might attain to more perfect maturity than thoſe on the drier one. I mention this peculiarity merely to ſhow how cautious the farmer ought to be in adopting general concluſions without carefully attending to all the collateral circumſtances that may affect his experiment. I ſhall only farther add on this head, that I had occaſion to know well a dry warm ſpot of ground on which the ſtems of the potatoes of crop 1776 were froſt-bitten at leaſt *ſix weeks* before thoſe on another ſpot at ſome miles diſtance from it, where the ſoil was naturally more cold and damp, were in the ſmalleſt degree affected by it. It likewiſe ſo happened, that the potatoes raiſed on the firſt-mentioned ſpot in the year 1777 (their own froſt-bitten (D) ſeed was employed) had ſuch a peculiar acrid and bitteriſh taſte as to be hardly at all eatable, while thoſe in the colder place of that crop had nothing of that unuſual

(D) Obſerve, the term *froſt-bitten* is here applied to the ſtems only, and not to the bulbs. The ſtems were ſo much hurt by the froſt as to turn black and decay, but the bulbs were taken up before the froſt had been ſufficiently intenſe to hurt them.

usual taste. Whether this diversity was occasioned by the circumstance here alluded to, I do not take it on me to say. In matters of such nice disquisition as the present, many facts obtained by very accurate observation are necessary before any conclusion can be relied on."

Potatoes, when planted in water, shoot out a great number of fine white roots like threads into the water; but on none of them is there to be found the least appearance of a bulb; while on the other hand the potatoes in that case always grow on the top. Potatoes are found to be extremely useful in bringing exhausted land into heart again. See AGRICULTURE, n° 35 and 186, p. 309, col. 1. The bishop of Killalue in Ireland directs the use of them for this purpose in a letter in the *Bath Papers*, vol. 4. p. 232, and confirms its utility in this respect by experiments of his own. In the 10th vol. of the *Transactions of the London Society for Encouragement of Arts*, &c. p. 34, there is also a most decisive proof of this utility.

We have been induced, from the extensive utility of this root, to extend our observations on the subject to a greater length than we should otherwise have done. Such of our readers as wish for further information, will of course consult the books from which we have made up the present article, as well as other books on Agriculture; in which they will find the observations and experiments which we have mentioned at much greater length than we could possibly give them. In the sixth volume of the *Bath Society Papers* there is an excellent paper on the culture of potatoes and feeding hogs with them during seven years by John Billingsley Esq; of which our limits do not permit us to take particular notice. There are also a variety of other papers in the several volumes of that work, as well as in the Transactions of the London Society, which we have already several times mentioned; which will deserve the particular attention of such as wish well to the poor, or have a desire still farther to extend the utility of this most valuable root. We have already mentioned a cheap preparation by means of potatoes for the poor, see AGRICULTURE, n° 161; and we shall finish the present article with a receipt to make a potato herrico, which may be equally useful to those whose circumstances are not such as to make them regardless of economy. We take it from the Gentleman's Magazine, and give it in the words of a person who had tried the experiment.

Scrape the skin clean off four pounds of good raw potatoes, then wash them clean in fair water: take two pounds of beef, one of mutton, and one of pork; or as you like best, four pounds of any of these meats; cut them into pieces of three or four ounces each, season them very well with pepper and salt and a good onion chopped very small: have ready a strong wide-mouthed stone-jar, such as hares are usually jugged in; slice thin a layer of the potatoes into the jar, then a layer of the seasoned meat over them, and so alternately layers of potatoes and meat; let your uppermost layer be potatoes, so that your jar be about three quarters full, but put no water into your jar; then close or stop the mouth of it with a large well-fitted piece of cork, covering the same with a strong piece of canvas, and tyeing it down with pack-thread, so as only a little of the steam may escape in the stewing; for a little should constantly evaporate from the side of the cork to save the jar from bursting. Then place your jar upright in a kettle of cold water on the fire, so as the mouth of the jar may be always two inches above the water in the kettle when boiling. The herrico in the jar will begin to boil some minutes sooner than the water in the kettle, and that for obvious reasons. In about an hour after the water in the kettle begins to boil, your herrico will be fully stewed. Then take out and open the jar, pour out the herrico into a deep dish, and serve it up.

This excellent, wholesome, and economical dish supplies an agreeable dinner twice a week to a family consisting of three grown people, and three children under fourteen years of age, where neither health nor good stomachs are wanting, thanks to God: and, in point of economy we must observe, that here is the whole article of butter saved, as also the whole article of bread, or nearly so; nor does there require so large or so continued a fire, nor so much time or trouble as is necessary for the dressing of many other dishes that by no means deserve the preference to this excellent herrico.

We have also (by way of change) made it with powdered beef, sometimes with powdered pork, sometimes with half fresh beef or mutton and half pickled pork, and found it good in all these ways, particularly with three pounds of fresh beef and one of pickled pork. We have left off sending pies and stews to the bakers. We sometimes (in a larger kettle) boil a small piece of powdered beef along-side of the jar, by continuing the boiling an hour and an half longer, and this serves us to eat cold the next day, with hot garden-stuff or a pudding.

POTATO-Bread. See *BREAD of Potatoes.*

Spanish POTATO. See CONVOLVULUS, n° 5.

POTENT, or POTENCE, in heraldry, a term for a kind of cross, whose ends all terminate like the head of a crutch. It is otherwise called the *Jerusalem cross*, and is represented Plate CCXXIX, fig. 12, 12.

POTENTIA (POWER), that whereby a thing is capable either of acting or being acted upon.

POTENTIAL, in the schools, is used to denote and distinguish a kind of qualities, which are supposed to exist in the body *in potentia* only; by which they are capable in some measure of affecting and impressing on us the ideas of such qualities, though not actually inherent in themselves; in which sense we say, potential heat, potential cold, &c.

POTENTIAL Cautery, in medicine, denotes the consuming, or reducing to an eschar, any part of the human body by a caustic alkaline or metallic salt, &c. instead of a red-hot iron, which last is called the *actual cautery*.

POTENTIAL, in grammar, an epithet applied to one of the moods of verbs. The potential is the same in form with the subjunctive, and is, according to Ruddiman, implied in that mood, for which reason that grammarian rejects it; but others will have it to differ from the subjunctive in this, that it always implies in it either *possum*, *volo*, or *debeo*. It is sometimes called the *permissive mood*, because it often implies a permission or concession to do a thing. See GRAMMAR.

POTENTILLA, SILVER-WEED, *wild tansey*, or *cinquefoil:* A genus of the pentagynia order, belonging to the icosandria class of plants; and in the natural method ranking under the 35th order, *Senticosæ*. The calyx is decemfid; there are five petals; the seeds roundish, naked, and affixed to a small dry receptacle. The species are, 1. The fruticosa, or shrubby potentilla, commonly

monly called *ſhrub-cinquefoil.* This riſes with a ſhort ſhrubby ſtem, dividing into a branchy full head, three or four feet high; cloſely garniſhed with pinnated leaves of five oblong, narrow, acute-pointed, folioles, pale green above, and whitiſh underneath; and the branches terminated by cluſters of large, ſpreading, yellow flowers. This is a beautiful deciduous flowering ſhrub, worthy a place in every curious collection. It grows wild in Yorkſhire and other northern parts of England, &c. but has been long cultivated in gardens as an ornamental ſhrub. 2. The reptans, or creeping common five-leaved potentilla, or five-leaved graſs, hath a thick fibry root, ſlender, trailing, repent ſtalks, digitated, five-lobed, petiolated leaves, and yellow flowers ſingly. 3. The rupeſtris, or mountain upright cinquefoil, hath upright ſtalks, eight or nine inches high; pinnated five and three-lobed alternate leaves, having oval crenated lobes, and the ſtalks terminated by ſmall white flowers. 4. The recta, or erect ſeven-lobed yellow cinquefoil, hath erect ſtalks, ſeven-lobed leaves; having three lobes ſpear-ſhaped and ſerrated, green and hairy on both ſides, and the ſtalks terminated by corymboſe cluſters of yellow flowers. 5. The fragaroides, or ſtrawberry-like trailing potentilla, hath a ſomewhat tuberous root, furniſhed with many long fibres, long trailing ſhoots, rooting at the joints; pinnated, moſtly three-lobed leaves, having oval lobes, with the extreme lobe the largeſt, and cluſters of ſmall white flowers. This ſpecies bears a great reſemblance to the ſmall ſterile ſtrawberry plants. 6. The argentea, ſilvery upright potentilla, hath upright ſtalks, branching a foot high; and five-lobed leaves, having the lobes wedge-ſhaped, cut on the edges, hoary and white underneath, and the branches terminated by ſmall yellow flowers.

All theſe plants flower in June and July; the flowers are compoſed each of five roundiſh petals, and about 20 ſtamina. They are all very hardy, and may be employed in the different compartments of the pleaſure ground. Their propagation is very eaſy. The ſhrubby potentilla may be propagated abundantly by ſuckers, layers, and cuttings; all of which will readily grow, and make plants in one year, which after having two or three years growth in the nurſery will be fit for any of the ſhrubbery compartments. All the herbaceous kinds may be propagated by parting the roots in autumn or ſpring, or by ſeed in any of thoſe ſeaſons.

POTERIUM, GARDEN BURNET: A genus of the polyandria order, belonging to the monœcia claſs of plants; and in the natural method ranking under the 54th order, *Miſcellaneæ.* The male calyx is tetraphyllous; the corolla quadripartite; and there are from 30 to 40 ſtamina. The female calyx is tetraphyllous; the corolla quadripartite; there are two piſtils; the berry is formed of the indurated tube of the corolla. The ſpecies are, 1. The ſanguiſorba, or common garden burnet, hath fibry perennial roots, crowned by a large tuft of pinnated leaves, or ſix or ſeven pair of ſawed lobes, terminated by an odd one; upright angular ſtalks, dividing, and branching a foot and a half high, terminated by oblong ſpikes of purpliſh red flowers. This ſpecies grows wild in England, in chalky ſoils; but has been long cultivated as a choice ſalad-herb for winter and ſpring uſe, it being of a warm nature; the young leaves are the uſeful parts. It is perennial in root, and retains its radical leaves all the year, but the ſtalks are annual. 2. The hybridum, hybrid agrimony-leaved Montpelier burnet, riſes with upright, taper, cloſely gathered ſtalks two feet high; pinnated odoriferous leaves of three or four pair of ſawed lobes, terminated by an odd one; and the ſtalks terminated by long footſtalks dividing into ſmaller, each ſupporting a ſmall roundiſh ſpike of flowers. This ſpecies often proves biennial; but by cutting down ſome of the ſtalks before they flower, it will cauſe it to multiply at bottom, and become abiding. 3. Poterium ſpinoſum, ſhrubby ſpinous burnet of Crete, hath a ſhrubby ſtem and branches, riſing a yard high, armed with ſpines; ſmall pinnated evergreen leaves, of ſix or ſeven pair of lobes, terminated by an odd one, and the branches terminated by ſmall heads of greeniſh flowers.

All theſe ſpecies flower in June and July, ſucceeded by ripe ſeeds in Autumn. They are all naturally perennial; but the two herbaceous ones are abiding in root only; the other in root, ſtem, and branches: the two former are hardy, and the third requires ſhelter in winter. The firſt ſort merits culture in every kitchen-garden for winter and ſpring ſalads. Some plants, both of the firſt and ſecond ſorts, may be introduced in the herbaceous collection in the pleaſure-garden for variety. The third ſort muſt be kept always in pots to have ſhelter in winter. They are all eaſily propagated, the firſt ſort by ſeed and by parting the roots. The ſecond ſort may alſo be increaſed by ſeeds and ſlips off the root, as for the former ſort. And the propagation of the third is by ſlips or cuttings of the branches in ſpring and ſummer, planted in pots, and placed under glaſſes, giving ſhade and water; or might be forwarded more by plunging them in a hot-bed.

Burnet is of a heating, drying nature, cordial and alexipharmac; in ſummer, the leaves are uſed for cool tankards, to give the wine an agreeable flavour. The powder of the root of the firſt ſpecies is commended againſt ſpitting of blood, bleeding at the noſe, dyſenteries, and diſeaſes attended with violent ſecretions. In winter and ſpring, the young tender leaves are uſed in ſalads. For its uſes as food for cattle, ſee AGRICULTURE, n° 184.

POTHOS, in botany; a genus of the polyandria order, belonging to the gynandria claſs of plants. The ſpatha or ſheath is a ſimple ſpadix covered; there is no calyx, but four petals, and as many ſtamina; the berries diſpermous.

POTION, a liquid medicine, conſiſting of as much as can be drunk at one draught.

POTIPHAR, or PUTIPHAR, an officer of the court of Pharaoh king of Egypt, and general of his troops, according to our tranſlation, Le Clerc, and the verſion of the vulgate; but according to the Hebrew and Septuagint, the chief of his butchers or cooks. The Hebrew text, the Septuagint, and vulgate, call him Eunuch. But it is probable it in this place means only an officer of the king's court; for he was certainly married and had children. We have no other accounts of him but what appear in ſcripture; and that account is too generally known to require to be enlarged on in this place. See Geneſis xxxviii. xxxix. &c.

POTOSI, a city of Peru in South America, ſituated at the bottom of a mountain of that name, in which is the richeſt ſilver mine ever diſcovered. To give an idea of its richneſs, we ſhall mention its produce at different

Potſdam, Pott.

ferent times. Excluſive of what was not regiſtered, ſays Abbé Raynal, and was ſmuggled away, the fifth part belonging to the government, from 1545 to 1564,
151,875 l. amounted to 36,450,000 livres * *per annum.* But this
abundance of metals ſoon decreaſed. From 1564 to
1585, the annual fifth part amounted to no more than
632,812 l. 15,187,489 livres four ſols §. From 1585 to 1624,
s it amounted to 12,149,994 livres 12 ſols †. From
506,249 l. 1624 to 1633, to 6,074,997 livres ſix ſols ‡. From
5 s. 6d. this laſt period, the produce of theſe mines hath ſo evi-
253,124 l. dently decreaſed, that in 1763 the fifth part, belong-
7 s. 9d. ing to the king, did not exceed 1,364,682 livres 12
56,861 l. ſols ‖. Situated in W. Long. 67. S. Lat. 22. See
5 s. 9d. the article Peru, p. 220, col. 2.

POTSDAM, or Postdam, a town of Germany, in the circle of Upper Saxony, with a palace, belonging to the king of Pruſſia. It is ſeated in an iſland ten miles in circumference, formed by the rivers Sprae and Havel. The palace is very curious, and finely built upon a delightful ſpot 12 miles weſt of Berlin. E. Long. 13. 42. N. Lat. 52. 34. Reiſbeck in his travels informs us, that the houſes in Potſdam are ſtill finer than thoſe of Berlin; but like them they are inhabited only by perſons of the lower and middling ranks.

POTT (Percival), was born in London in 1713. He received the firſt rudiments of his education at a private ſchool at Darne in Kent; and became an apprentice to Mr Nourſe, one of the ſurgeons of St Bartholomew's hoſpital; of which hoſpital, in 1744-5, he was elected an aſſiſtant ſurgeon, and in 1749 appointed one of the principal ſurgeons. In 1746, he married the daughter of Robert Cruttenden, Eſq. His firſt publication is ſaid to have been planned in 1756, during his confinement in conſequence of a compound fracture of the leg: from that time, his pen was ſeldom long unemployed. His practice and his reputation were now rapidly increaſing: in 1764, he was elected a fellow of the Royal Society; and afterward was complimented with honorary diplomas from the Royal Colleges of Surgeons at Edinburgh and in Ireland. In 1787, he reſigned the office of ſurgeon to St Bartholomew's hoſpital, "after having ſerved it (as he uſed to ſay), man and boy, half a century;" and on the 22d of December 1788, after an illneſs of eight days, he expired.

"The labours of the greateſt part of his life (ſays Mr Earle, who publiſhed his Chirurgical works), were without relaxation; an increaſing family required his utmoſt exertion: of late years he had a villa at Neaſden; and in the autumn uſually paſſed a month at Bath, or at the ſea-ſide. Thus, though he gathered, as he expreſſed it, ſome of the fruit of the garden which he had planted as he went along, and always lived in a generous and hoſpitable manner, at the ſame time beſtowing on four ſons and four daughters a liberal and neceſſarily expenſive education, and applying large ſums to their eſtabliſhment during his lifetime, he left an ample proviſion for them at his deceaſe. Among his papers was found, what he had often mentioned, a ſmall box, containing a few pieces of money, being the whole which he ever received from the wreck of his father's fortune. With this was depoſited an exact account of every individual fee which a long life of buſineſs had produced—abundant evidence of well ſpent time, and the induſtrious application of abilities, to which the *res anguſta domi*, at the commencement, probably acted more powerfully as an incentive than as an obſtacle."

Potter, Pottery.

POTTER (Chriſtopher), a learned Engliſh divine, was born in 1591, and bred at Oxford. In 1633, he publiſhed his "Anſwer to a late Popiſh Plot," intitled *Charity miſtaken*, which he wrote by ſpecial order of King Charles I. whoſe chaplain he was. In 1634, he was promoted to the deanery of Worceſter; and, in 1640, was conſtituted vice-chancellor of the univerſity of Oxford, in the execution of which office he met with ſome trouble from the members of the long parliament. Upon breaking out of the civil wars, he ſent all his plate to the king, declaring, "that he would rather, like Diogenes, drink in the hollow of his hand, than that his majeſty ſhould want;" and he afterwards ſuffered much for the royal cauſe. In conſideration of this he was nominated to the deanery of Durham in 1646, but was prevented from being inſtalled by his death, which happened about two months after. He was a perſon learned and religious, exemplary in his converſation, courteous in his carriage, of a ſweet and obliging nature, and of a comely preſence. He was remarkable in his charity to the poor.

Potter (Dr John), archbiſhop of Canterbury, was the ſon of a linen-draper at Wakefield in Yorkſhire, where he was born about the year 1674. He ſtudied at Univerſity college, Oxford; and at 19 publiſhed *Variantes lectiones & notæ ad Plutarchi librum de audiendis poetis; & ad Baſilii magni orationem ad juvenes, quomodo cum fructu legere poſſint Græcorum libros*, 8vo, 1693. In 1697, came out his edition of *Lycophron*, in folio; which is reckoned the beſt of that obſcure writer: ſoon after, he publiſhed his *Antiquities of Greece*, 2 vols 8vo. Theſe works eſtabliſhed his literary reputation, and engaged him in a correſpondence with Grævius and other learned foreigners. In 1706, he was made chaplain to the queen; in 1715, biſhop of Oxford; and in 1737, he ſucceeded archbiſhop Wake in the ſee of Canterbury; which high ſtation he ſupported with much dignity until his death in 1747. He was a learned and exemplary churchman; but not of an amiable diſpoſition, being but too ſtrongly tinctured with the pride of office; nor is it to his credit that he diſinherited his eldeſt ſon for marrying below his rank in life. His "Theological works, containing ſermons, charges, diſcourſes on church-government, and divinity lectures," were printed at Oxford, in 3 vols, 8vo, 1753.

POTTERY, the manufacture of earthen-ware, or the art of making earthen veſſels. See *Delft-Ware*, *Stone-Ware*, and Porcelain, &c.

The wheel and lathe are the chief and almoſt the only inſtruments in pottery: the firſt for large works, and the laſt for ſmall. The potter's wheel conſiſts principally in the nut, which is a beam or axis, whoſe foot or pivot plays perpendicularly on a free-ſtone ſole or bottom. From the four corners of this beam, which does not exceed two feet in height, ariſe four iron bars, called the *ſpokes of the wheel;* which forming diagonal lines with the beam, deſcend, and are faſtened at bottom to the edges of a ſtrong wooden circle, four feet in diameter, perfectly like the felloes of a coach-wheel, except that it has neither axis nor radii, and is only joined to the beam, which ſerves it as an axis by the iron-bars. The top of the nut is flat, of a circular

cular figure, and a foot in diameter: and on this is laid the clay which is to be turned and fashioned. The wheel thus disposed is encompassed with four sides of four different pieces of wood fastened on a wooden frame; the hind-piece, which is that on which the workman sits, is made a little inclining towards the wheel; on the fore-piece are placed the prepared earth; on the side-pieces he rests his feet, and these are made inclining to give him more or less room. Having prepared the earth, the potter lays a round piece of it on the circular head of the nut, and sitting down turns the wheel with his feet till it has got the proper velocity; then, wetting his hands with water, he presses his fist or his fingers-ends into the middle of the lump, and thus forms the cavity of the vessel, continuing to widen it from the middle; and thus turning the inside into form with one hand, while he proportions the outside with the other, the wheel constantly turning all the while, and he wetting his hands from time to time. When the vessel is too thick, he uses a flat piece of iron, somewhat sharp on the edge, to pare off what is redundant; and when it is finished, it is taken off from the circular head by a wire passed under the vessel.

The potter's lathe is also a kind of wheel, but more simple and slight than the former: its three chief members are an iron beam or axis three feet and a half high, and two feet and a half diameter, placed horizontally at the top of the beam, and serving to form the vessel upon: and another larger wooden wheel, all of a piece, three inches thick, and two or three feet broad, fastened to the same beam at the bottom, and parallel to the horizon. The beam or axis turns by a pivot at the bottom in an iron stand. The workman gives the motion to the lathe with his feet, by pushing the great wheel alternately with each foot, still giving it a greater or lesser degree of motion as his work requires. They work with the lathe with the same instruments, and after the same manner, as with the wheel. The mouldings are formed by holding a piece of wood or iron cut in the form of the moulding to the vessel, while the wheel is turning round; but the feet and handles are made by themselves and set on with the hand; and if there be any sculpture in the work, it is usually done in wooden moulds, and stuck on piece by piece on the outside of the vessel. For the glazing of the work, see GLAZING.

POTTLE, an English measure containing two quarts.

POVERTY signifies indigence or want of riches, and has been the lot of a large portion of men in every age. Whether, on the whole, it has been productive of good or bad consequences, has been disputed. In a moral view, perhaps it has been, on the whole, useful, as adversity is in general more conducive to virtue than prosperity, which too often leads to luxury and vice.—Sometimes, however, poverty has had a baneful effect upon the mind, and has prompted men to commit very inhuman actions; but this in civilized communities very seldom occurs. In a political view, poverty is thought by some to be hurtful: Raynal thinks it is a check to population, (see his History, vol. vi. p. 471.); and Dr Smith so far agrees with him; for though he asserts, and indeed proves, that poverty is no check to the production of children, he allows it to be very unfavourable to raising them. See *Smith's Wealth of Nations*, vol. i. p. 119, &c. See also POOR.

POULADUFF, two remarkable great holes in the ground, about a mile west of Ross, in the county of Cork, and province of Munster, in Ireland, 80 yards deep, in which the sea flows by subterraneous passages. They are called East and West *Pouladuff*; one is on the lands of Downeen, and the other on Tralong.

POULTICE, a sort of medicine, called also a *cataplasm*. See CATAPLASMA.

POULTRY, all kind of domestic birds brought up in yards, as cocks, hens, capons, ducks, turkeys, &c.

Almost, if not all the domestic birds of the poultry kind that we maintain in our yards are of foreign extraction: but there are others to be ranked in this class that are as yet in a state of nature, and perhaps only wait till they become sufficiently scarce to be taken under the care of man to multiply their propagation. It will appear remarkable enough, if we consider how much the tame poultry which we have imported from distant climates has increased, and how much those wild birds of the poultry kind that have never yet been taken into keeping have been diminished and destroyed. They are all thinned; and many of the species, especially in the more cultivated and populous parts of the kingdom, are utterly unseen.

Under birds of the poultry kind may be ranked all those that have white flesh, and, comparatively to their heads and limbs, have bulky bodies. They are furnished with short strong bills for picking up grain, which is their chief and often their only sustenance. Their wings are short and concave; for which reason they are not able to fly far. They lay a great many eggs; and as they lead their young abroad, the very day they are hatched, in quest of food, which they are shown by the mother, and which they pick up for themselves, they generally make their nests on the ground. The toes of all these are united by a membrane as far as the first articulation, and are then divided.

Under this class we may therefore render the common cock, the peacock, the turkey, the pintada or Guinea hen, the pheasant, the bustard, the grous, the partridge, and the quail. They all bear a strong similitude to each other, being equally granivorous, fleshy, and delicate to the palate. They are among birds what beasts of pasture are among quadrupeds, peaceable tenants of the field, and shunning the thicker parts of the forest, that abound with numerous animals who carry on unceasing hostilities against them.

As nature has formed the rapacious class for war, so she seems equally to have fitted these for peace, rest, and society. Their wings are but short, so that they are ill formed for wandering from one region to another: their bills are also short, and incapable of annoying their opposers: their legs are strong indeed; but their toes are made for scratching up their food, and not for holding or tearing it. These are sufficient indications of their harmless nature; while their bodies, which are fat and fleshy, render them unwieldy travellers, and incapable of straying far from each other.

Accordingly, we find them chiefly in society: they live together: and though they may have their disputes, like all other animals, upon some occasions; yet, when kept in the same district, or fed in the same

ſame yard, they learn the arts of ſubordination; and, in proportion as each knows his ſtrength, he ſeldom tries a ſecond time the combat where he has once been worſted.

In this manner, all of this kind ſeem to lead an indolent voluptuous life. As they are furniſhed internally with a very ſtrong ſtomach, commonly called a *gizzard*, ſo their voraciouſneſs ſcarce knows any bounds. If kept in cloſe captivity, and ſeparated from all their former companions, they have ſtill the pleaſure of eating left; and they ſoon grow fat and unwieldy in their priſon. To ſay this more ſimply, many of the wilder ſpecies of birds, when cooped or caged, pine away, grow gloomy, and ſome refuſe all ſuſtenance whatever; none except thoſe of the poultry kind grow fat, who ſeem to loſe all remembrance of their former liberty, ſatisfied with indolence and plenty.

POUNCE, gum ſandarach pounded and ſifted very fine, to rub on paper, in order to preſerve it from ſinking, and to make it more fit to write upon.

Pounce, is alſo a little heap of charcoal duſt, incloſed in a piece of muſlin or ſome other open ſtuff, to be paſſed over holes pricked in a work, in order to mark the lines or deſigns thereof on paper, ſilk, &c. placed underneath; which are to be afterwards finiſhed with a pen and ink, a needle, or the like. This kind of pounce is much uſed by embroiderers, to transfer their patterns upon ſtuffs; by lace-makers, and ſometimes alſo by engravers.

Pounces, in falconry, the talons or claws of a bird of prey.

POUND, a ſtandard-weight; for the proportion and ſubdiviſions of which, ſee the article Weight.

Pound alſo denotes a money of account; ſo called, becauſe the ancient pound of ſilver weighed a pound troy.

Pound, among lawyers, denotes a place of ſtrength, in which to keep cattle that are diſtrained, or put in for treſpaſs, until they are replevied or redeemed.

POUNDAGE, a ſubſidy of 12 d. in the pound, granted to the crown on all goods and merchandizes exported or imported; and if by aliens, one penny more.

POURPRESTURE, in law, is a wrongful incloſure, or incroachment upon another perſon's property.

POURSUIVANT, or Pursuivant, in heraldry, the loweſt order of officers at arms.—They are properly attendants on the heralds when they marſhal public ceremonies. Of theſe in England there were formerly many; but at preſent there are only four, viz. blue-mantle, rouge-croſs, rouge-dragon, and port-cullice. In Scotland there is only one king at arms, who is ſtyled *Lyon;* and has under him no leſs than ſix heralds, as many purſuivants, and a great many meſſengers at arms. See Lyon.

POURVEYANCE, or Purveyance, in law, the providing corn, fuel, victuals, &c. for the king's houſehold; and hence the officer who did ſo was termed *pourveyor*. As ſeveral offences were committed by theſe officers, it was enacted by ſtat. 12. Car. II. that no perſon, under colour of pourveyance, ſhall take any timber, cattle, corn, &c. from any ſubject without his free conſent, or without a juſt appraiſement and paying for the ſame.

POUSSIN (Nicholas), an eminent French painter, born in 1594, at Andel, a little city in Normandy, where his father was of noble extraction, but born to a ſmall eſtate. He was inſtructed for a few months by one Ferdinand Elle, a portrait-painter, and afterwards ſpent a month with L'Allemant; but finding theſe artiſts not likely to improve him ſuitably to his deſires, he firſt ſtudied the paintings of the beſt maſters, and then haſtened to finiſh a few pieces he was engaged in, and travelled to Italy. Here he devoted almoſt his whole attention to the ſtudy of antique ſtatues and bas reliefs; which was probably the cauſe of his want of knowledge in, and taſte for, the art of colouring. Being invited back to Paris by Louis XIII. who aſſigned him a penſion with lodgings in the Thuilleries, he painted for prince Juſtiniani an hiſtorical picture repreſenting Herod's cruelty; an admirable compoſition, in which he gave ſuch expreſſion to every character, as could not fail to ſtrike the beholder with terror and pity: he then laboured for ſeveral years on the celebrated pictures of the ſeven ſacraments of the Romiſh church. But none of Pouſſin's deſigns have been more generally admired than that of the death of Germanicus; which would have gained him immortal honour if he had never painted another picture. He began the labours of Hercules in the gallery of the Louvre; but the faction of Vouet's ſchool railing at him and his performances, put him ſo out of humour with his own country, that he returned to Rome, where he died in 1665. He never went beyond eaſel-pieces, for which he had a perpetual demand; and his method was to fix the price he expected on the back of the canvas, which was readily paid.

Poussin (Gaſpar). This painter, whoſe real name was *Dughet*, was born at Paris in 1600; and was induced to travel to Rome, not only from a love to the art of painting, but alſo to viſit his ſiſter, who was married to Nicholas Pouſſin. Sandrart ſays that Gaſpar was employed at firſt only to prepare the pallet, pencils, and colours, for Nicholas; but by the precepts and example of that excellent maſter, gradually roſe to the higheſt reputation, and is undoubtedly one of the beſt landſcape-painters that ever appeared. It is generally thought that no painter ever ſtudied nature to better purpoſe, or repreſented the effects of land-ſtorms more happily, than Gaſpar; all his trees ſhow a natural degree of agitation, every leaf being in motion; his ſcenes are all beautifully choſen, as are the ſites of his buildings. He deſigned human figures but very indifferently; for which reaſon he frequently prevailed on Nicholas to paint them for him; and they were always introduced with the utmoſt propriety. While he continued at Rome he dropped his own name, and aſſumed that of his brother-in-law and benefactor, by which only he is at preſent known. He died in 1662.

POWDER, in pharmacy, a dry medicine well broken, either in a mortar by grinding or by ſome chemical operation.

Gun-Powder. See Gunpowder. See alſo Obſervations on Gunpowder in the Iriſh Tranſactions 1788, p. 97. claſs *Science*, by Mr Napier.

Powder-Cheſts, certain ſmall boxes charged with powder and a quantity of old nails or ſplinters of iron, and faſtened occaſionally on the deck and ſides of a ſhip, in order to be diſcharged on an enemy who attempts to ſeize her by boarding. Theſe caſes are uſually

ally from 12 to 18 inches in length, and about eight or ten in breadth, having their outer or upper part terminating in an edge. They are nailed to feveral places of the quarter-deck and bulk-head of the waift, having a train of powder, which communicates with the inner apartments of the fhip, fo as to be fired at pleafure to annoy the enemy. They are particularly ufed in merchant-fhips which are furnifhed with clofe-quarters to oppofe the boarders.

Powder-Magazine, a bomb-proof arched building, to contain powder in fortified places.

Powder for the Hair. The beft fort is ftarch well pounded and fifted, and generally prepared with fome perfume.

James's Powder. See *James's Powder*. In the Philofophical Tranfactions for 1791, p. 317. there is a paper by Dr Pearfon, containing experiments and obfervations on James's powder. Dr Pearfon fays, it was originally a patent medicine; but it is well known that it cannot be prepared by following the directions of the fpecification in the court of chancery. His obfervations and experiments, therefore, he thinks, may explain the nature and manner of preparing this medicine, and perhaps may extend the hiftory of antimony. The refult of the whole, in Dr Pearfon's own words, is as follows:

1. James's powder confifts of phofphoric acid, lime, and antimonial calx; with a minute quantity of calx of iron, which is confidered to be an accidental fubftance. 2. Either thefe three effential ingredients are united with each other, forming a triple compound, or phofphorated lime is combined with the antimonial calx, compofing a double compound in the proportion of about 57 parts of calx and 43 parts of phofphorated lime. 3. This antimonial calx is different from any other known calx of antimony in feveral of its chemical qualities. About three-fourths of it are foluble in marine acid, and afford Algaroth powder; and the remainder is not foluble in this menftruum, and is apparently vitrified. It alfo appears, that by calcining together bone-afhes, that is, phofphorated lime and antimony in a certain proportion, and afterwards expofing the mixture to a white heat, a compound was formed, confifting of antimonial calx and phofphorated lime in the fame proportion, and poffeffing the fame kind of chemical properties as James's powder.

POWDIKE, in the fens of Norfolk and Ely. By ftat. 22 Hen. VIII. c. 11. perverfely to cut down and deftroy the powdike in the fens of Norfolk and Ely is felony. See *Blackftone's Commentaries*, vol. iv. p. 243.

POWER, has been defined the faculty of doing or fuffering any thing. Power, therefore, is two-fold, viz. confidered as able to make, or able to receive, any change; the former whereof may be called *active*, and the latter *paffive, power:* but this diftinction is improper. See Metaphysics, n° 116.

Power, in mechanics, denotes any force, whether of a man, a horfe, a fpring, the wind, water, &c. which, being applied to a machine, tends to produce motion.

Power, in law, fignifies in general a particular authority granted by any perfon to another to reprefent him, or to act in his ftead.

POWERS, in arithmetic and algebra, are nothing but the products arifing from the continual multiplications of a number or quantity into itfelf. See Algebra and Arithmetic.

POX, *French-Pox*, or *Lues Venerea*. See Medicine, n° 350.

Small-Pox. See Inoculation, and Medicine, n° 222—226.

POYNING's law, an act of parliament made in Ireland under Henry VII. whereby all the ftatutes of force in England were made of force in Ireland; which before that time they were not.—Nor are any now in force there made in England fince that time.

The law took its name from Sir Edward Poyning, lord-lieutenant of that kingdom at the time of its making. See Ireland, n° 46.

POZZOLANA. See Puzzolana.

PRACTICE, in arithmetic. See there, n° 16. &c.

Gun-Practice, in military education. In the fpring, as foon as the weather permits, the exercife of the great guns begins, with an intention to fhow the gentlemen cadets at the royal military academy at Woolwich, and private men, the manner of laying, loading, pointing, and firing the guns. Sometimes inftruments are ufed to find the centre line, or two points, one at the breech, the other at the muzzle, which are marked with chalk, and whereby the piece is directed to the target: then a quadrant is put into the mouth to give the gun the required elevation, which at firft is gueffed at, according to the diftance the target is from the piece. When the piece has been fired, it is fponged to clear it from any duft or fparks of fire that might remain in the bore, and loaded: then the centre line is found as before; and if the fhot went too high or too low, to the right or to the left, the elevation and trail are altered accordingly. This practice continues morning and evening for about fix weeks, more or lefs according as there are a greater or lefs number of recruits. In the mean time others are fhown the motions of quick-firing with field-pieces.

Mortar-Practice, generally thus. A line of 1500 or 2000 yards is meafured in an open fpot of ground from the place where the mortars ftand, and a flag fixed at about 300 or 500 yards: this being done, the ground where the mortars are to be placed is prepared and levelled with fand, fo that they may lie at an elevation of 45 degrees; then they are loaded with a fmall quantity of powder at firft, which is increafed afterwards by an ounce every time, till they are loaded with a full charge; the times of the flights of the fhells are obferved, to determine the length of the fuzes. The intention of this practice is, when a mortar battery is raifed in a fiege, to know what quantity of powder is required to throw the fhells into the works at a given diftance, and to cut the fuzes of a juft length, that the fhell may burft as foon as it touches the ground.

PRÆMUNIRE, in law, is taken either for a writ fo called, or for the offence whereon the writ is granted; the one may be underftood by the other.—The church of Rome, under pretence of her fupremacy and the dignity of St Peter's chair, took on her to beftow moft of the ecclefiaftical livings of any worth in England, by mandates, before they were void; pretending therein great care to fee the church provided of a fucceffor before it needed. Whence thefe mandates or bulls were called *gratiæ expectativæ*, or *provifiones*; whereof fee a learned difcourfe in *Duarenus de beneficiis*,

beneficiis, lib. 3. cap. 1. Theſe proviſions were ſo common, that at laſt Edward I. not digeſting ſo intolerable an encroachment, in the 35th year of his reign made a ſtatute againſt papal proviſions, which, according to Sir Edward Coke, is the foundation of all the ſubſequent ſtatutes of præmunire: which is ranked as an offence immediately againſt the king, becauſe every encouragement of the papal power is a diminution of the authority of the crown.

In the weak reign of Edward II. the pope again endeavoured to encroach, but the parliament manfully withſtood him; and it was one of the articles charged againſt that unhappy prince, that he had given allowance to the bulls of the ſee of Rome. But Edw. III. was of a temper extremely different; and, to remedy theſe inconveniences, firſt by gentle means, he and his nobility wrote an expoſtulation to the pope: but receiving a menacing and contemptuous anſwer, withal acquainting him, that the emperor (who a few years before at the diet of Nuremberg, A. D. 1323, had eſtabliſhed a law againſt proviſions), and alſo the king of France, had lately ſubmitted to the holy ſee; the king replied, that if both the emperor and the French king ſhould take the pope's part, he was ready to give battle to them both, in defence of the liberties of the crown. Hereupon more ſharp and penal laws were deviſed againſt proviſors, which enact ſeverally, that the court of Rome ſhall preſent or collate to no biſhopric or living in England; and that whoever diſturbs any patron in the preſentation to a living by virtue of a papal proviſion, ſuch proviſor ſhall pay fine and ranſom to the king at his will, and be impriſoned till he renounces ſuch proviſion; and the ſame puniſhment is inflicted on ſuch as cite the king, or any of his ſubjects, to anſwer in the court of Rome. And when the holy ſee reſented theſe proceedings, and pope Urban V. attempted to revive the vaſſalage and annualrent to which king John had ſubjected his kingdom, it was unanimouſly agreed by all the eſtates of the realm in parliament aſſembled, 40 Edw. III. that king John's donation was null and void, being without the concurrence of parliament, and contrary to his coronation-oath; and all the temporary nobility and commons engaged, that if the pope ſhould endeavour by proceſs or otherwiſe to maintain theſe uſurpations, they would reſiſt and withſtand him with all their power.

In the reign of Richard II. it was found neceſſary to ſharpen and ſtrengthen theſe laws, and therefore it was enacted by ſtatutes 3 Ric. II. c. 3. and 7 Ric. II. c. 12. firſt, that no alien ſhall be capable of letting his benefice to farm; in order to compel ſuch as had crept in, at leaſt to reſide on their preferments: and afterwards, that no alien ſhould be capable to be preſented to any eccleſiaſtical preferment, under the penalty of the ſtatutes of proviſors. By the ſtatute 12 Rich. II. c. 15. all liegemen of the king accepting of a living by any foreign proviſion, are put out of the king's protection, and the benefice made void. To which the ſtatute 13 Rich. II. ſt. 2. c. 2. adds baniſhment and forfeiture of lands and goods: and by c. 3. of the ſame ſtatute, any perſon bringing over any citation or excommunication from beyond ſea, on account of the execution of the foregoing ſtatutes of proviſors, ſhall be impriſoned; forfeit his goods and lands, and moreover ſuffer pain of life and member.

Præmunire.

In the writ for the execution of all theſe ſtatutes, the words *præmunire facias* being uſed to command a citation of the party, have denominated in common ſpeech, not only the writ, but the offence itſelf of maintaining the papal power, by the name of *præmunire*. And, accordingly, the next ſtatute we ſhall mention, which is generally referred to by all ſubſequent ſtatutes, is uſually called the *ſtatute of præmunire*. It is the ſtatute 16 Richard II. c. 5. which enacts, that whoever procures at Rome, or elſewhere, any tranſlations, proceſſes, excommunications, bulls, inſtruments, or other things which touch the king, againſt him, his crown, and realm, and all perſons aiding and aſſiſting therein, ſhall be put out of the king's protection, their lands and goods forfeited to the king's uſe, and they ſhall be attached by their bodies to anſwer to the king and his council; or proceſs of *præmunire facias* ſhall be made out againſt them as in other caſes of proviſors.

By the ſtatute 2 Henry IV. c. 3. all perſons who accept any proviſion from the pope, to be exempt from canonical obedience to their proper ordinary, are alſo ſubjected to the penalties of præmunire. And this is the laſt of our ancient ſtatutes touching this offence; the uſurped civil power of the biſhop of Rome being pretty well broken down by theſe ſtatutes, as his uſurped religious power was in about a century afterwards: the ſpirit of the nation being ſo much raiſed againſt foreigners, that about this time, in the reign of Hen. V. the alien priories, or abbeys for foreign monks, were ſuppreſſed, and their lands given to the crown. And no farther attempts were afterwards made in ſupport of theſe foreign juriſdictions.

This, then, is the original meaning of the offence which we call *præmunire*; viz. introducing a foreign power into this land, and creating *imperium in imperio*, by paying that obedience to papal proceſs which conſtitutionally belonged to the king alone, long before the Reformation in the reign of Henry VIII. at which time the penalties of præmunire were indeed extended to more papal abuſes than before; as the kingdom then entirely renounced the authority of the ſee of Rome, though not at all the corrupted doctrines of the Roman church. And therefore, by the ſeveral ſtatutes of 24 Hen. VIII. c. 12. and 25 Hen. VIII. c. 19. & 21. to appeal to Rome from any of the king's courts, which (though illegal before) had at times been connived at; to ſue to Rome for any licence or diſpenſation, or to obey any proceſs from thence, are made liable to the pains of præmunire. And, in order to reſtore to the king in effect the nomination of vacant biſhoprics, and yet keep up the eſtabliſhed forms, it is enacted by ſtatute 25 Hen. VIII. c. 20. that if the dean and chapter refuſe to elect the perſon named by the king, or any archbiſhop or biſhop to confirm or conſecrate him, they ſhall fall within the penalties of the ſtatutes of præmunire. Alſo by ſtatute 5 Eliz. c. 1. to refuſe the oath of ſupremacy will incur the pains of præmunire; and to defend the pope's juriſdiction in this realm, is a præmunire for the firſt offence, and high treaſon for the ſecond. So, too, by ſtatute 13 Eliz. c. 2. to import any *agnus Dei*, croſſes, beads, or other ſuperſtitious things pretended to be hallowed by the biſhop of Rome, and tender the ſame to be uſed; or to receive the ſame with ſuch intent, and not diſcover the offender; or if a juſtice of the peace, knowing thereof, ſhall not within

Præmunire.

14 days declare it to a privy-counſellor, they all incur a præmunire. But importing or ſelling maſs-books, or other Popiſh books, is by ſtat. 3 Jac. I. c. 5. § 25. only liable to a penalty of 40 s. Laſtly, to contribute to the maintenance of a Jeſuit's college, or any Popiſh ſeminary whatever beyond ſea, or any perſon in the ſame, or to contribute to the maintenance of any Jeſuit or Popiſh prieſt in England, is by ſtatute 27 Eliz. c. 2. made liable to the penalties of præmunire.

Thus far the penalties of præmunire ſeem to have kept within the proper bounds of their original inſtitution, the depreſſing the power of the pope: but they being pains of no conſiderable conſequence, it has been thought fit to apply the ſame to other heinous offences; ſome of which bear more, and ſome leſs, relation to this original offence, and ſome no relation at all.

Thus, 1. By the ſtatute 1 & 2 Ph. and Mar. c. 8. to moleſt the poſſeſſors of abbey-lands granted by parliament to Henry VIII. and Edward VI. is a præmunire. 2. So likewiſe is the offence of acting as a broker or agent in any uſurious contract where above 10 *per cent.* intereſt is taken, by ſtatute 13 Eliz. c. 10. 3. To obtain any ſtay of proceedings, other than by arreſt of judgment or writ of error, in any ſuit for a monopoly, is likewiſe a præmunire, by ſtat. 21 Jac. I. c. 3. 4. To obtain an excluſive patent for the ſole making or importation of gunpowder or arms, or to hinder others from importing them, is alſo a præmunire by two ſtatutes; the one 16 Car. I. c. 21. the other 1 Jac. II. c. 8. 5. On the abolition, by ſtat. 12. Car. II. c. 24. of purveyance, and the prerogative of pre-emption, or taking any victual, beaſts, or goods for the king's uſe, at a ſtated price, without conſent of the proprietor, the exertion of any ſuch power for the future was declared to incur the penalties of præmunire. 6. To aſſert, maliciouſly and adviſedly, by ſpeaking or writing, that both or either houſe of parliament have a legiſlative authority without the king, is declared a præmunire by ſtatute 13 Car. II. c. 1. 7. By the *habeas corpus* act alſo, 31 Car. II. c. 2. it is a præmunire, and incapable of the king's pardon, beſides other heavy penalties, to ſend any ſubject of this realm a priſoner into parts beyond the ſeas. 8. By the ſtatute 1 W. & M. ſt. 1. c. 8. perſons of 18 years of age refuſing to take the new oaths of allegiance as well as ſupremacy, upon tender by the proper magiſtrate, are ſubject to the penalties of a præmunire; and by ſtatutes 7 & 8 W. III. c. 24. ſerjeants, counſellors, proctors, attorneys, and all officers of courts, practiſing without having taken the oaths of allegiance and ſupremacy, and ſubſcribed the declaration againſt popery, are guilty of a præmunire whether the oaths be tendered or not. 9. By the ſtatute 6 Ann. c. 7. to aſſert maliciouſly and directly, by preaching, teaching, or adviſed ſpeaking, that the then pretended prince of Wales, or any perſon other than according to the acts of ſettlement and union, hath any right to the throne of theſe kingdoms, or that the king and parliament cannot make laws to limit the deſcent of the crown; ſuch preaching, teaching, or adviſed ſpeaking, is a præmunire: as writing, printing, or publiſhing the ſame doctrines amounted, we may remember, to high treaſon. 10. By ſtatute 6 Ann. c. 23. if the aſſembly of peers of Scotland, convened to elect their 16 repreſentatives in the Britiſh parliament, ſhall preſume to treat of any other matter ſave only the election, they incur the penalties of a præmunire. 11. The ſtat. 6 Geo. I. c. 18. (enacted in the year after the infamous South Sea project had beggared half the nation) makes all unwarrantable undertakings by unlawful ſubſcriptions, then commonly known by the name of *bubbles*, ſubject to the penalties of a præmunire. 12. The ſtat. 12 Geo. III. c. 11. ſubjects to the penalties of the ſtatute of præmunire all ſuch as knowingly and wilfully ſolemnize, aſſiſt, or are preſent at, any forbidden marriage of ſuch of the deſcendants of the body of king Geo. II. as are by that act prohibited to contract matrimony without the conſent of the crown.

Having thus inquired into the nature and ſeveral ſpecies of præmunire, its puniſhment may be gathered from the foregoing ſtatutes, which are thus ſhortly ſummed up by Sir Edward Coke: "That, from the conviction, the defendant ſhall be out of the king's protection, and his lands and tenements, goods and chattels, forfeited to the king; and that his body ſhall remain in priſon at the king's pleaſure, or (as other authorities have it) during life; both which amount to the ſame thing, as the king by his prerogative may any time remit the whole, or any part of the puniſhment, except in the caſe of tranſgreſſing the ſtatute of *habeas corpus*. Theſe forfeitures here inflicted do not (by the way) bring this offence within our former definition of Felony; being inflicted by particular ſtatutes, and not by the common law." But ſo odious, Sir Edward Coke adds, was this offence of præmunire, that a man that was attainted of the ſame, might have been ſlain by any other man without danger of law; becauſe it was provided by law, that any man might do to him as to the king's enemy; and any man may lawfully kill an enemy. However, the poſition itſelf, that it is at any time lawful to kill an enemy, is by no means tenable: it is only lawful, by the law of nature and nations, to kill him in the heat of battle, or for neceſſary ſelf-defence. And to obviate ſuch ſavage and miſtaken notions, the ſtatute 5 Eliz. c. 1. provides, that it ſhall not be lawful to kill any perſon attainted in a præmunire, any law, ſtatute, opinion, or expoſition of law to the contrary notwithſtanding. But ſtill ſuch delinquent, though protected as a part of the public from public wrongs, can bring no action for any private injury, how atrocious ſoever; being ſo far out of the protection of the law, that it will not guard his civil rights, nor remedy any grievance which he as an individual may ſuffer. And no man, knowing him to be guilty, can with ſafety give him comfort, aid, or relief.

Præmunire Præneste.

PRÆNESTE (anc. geog.), a town of Latium, to the ſouth-eaſt of Rome, towards the territory of the Æqui; a place of great ſtrength. Famous for the temple and oracle of Fortune, called *Sortes Prænestinæ* (Strabo); which Tiberius wanted to deſtroy, but was deterred by the awful majeſty of the place. From a colony it was raiſed to a municipium by Tiberius (Inſcriptions, Florus, A. Gellius), on the conſideration of his recovery from a dangerous illneſs near this place. Thither the Roman emperors uſually retired, on account of the agreeableneſs of the ſituation (Suetonius). It was a very ancient city, with a territory of large extent (Livy). The temple of Fortune was built in the moſt ſumptuous manner by Sylla, and the pavement was Moſaic work (Pliny). Concerning the Sortes, there is a remarkable paſſage in Cicero; who ſays, that it was all

Præsidium || Prague.

a mere contrivance, in order to deceive, either for the purposes of gain or superstition. The town that has succeeded it stands low in a valley, and is called *Palestrina*, in the Campania of Rome. E. Long. 13. 30. N. Lat. 42. 0.

PRÆSIDIUM (Notitia), a town of the Cornavii in Britain. Now thought to be Warwick (Camden).—Another of Corsica (Antonine), 30 miles to the south of Aleria.—A third *Præsidium* surnamed *Julium*, in Bætica (Pliny).

PRÆTORIA AUGUSTA (Ptolemy), a town of Dacia. Now called *Brassow* by the natives, and *Cronstat* by the Germans (Baudrand): a town in Transylvania. E. Long. 25°. N. Lat. 47°.—Another of the Salassii, near the two gates or defiles of the Alps, the Grajæ and Penninæ (Pliny); a Roman colony, settled by Augustus after the defeat of the Salassii by Terentius Varro, on the spot where he encamped (Strabo, Dio Cassius, Ptolemy), situated on the river Duria Major. The town is now called *Aosta* or *Aoust*, in Piedmont. E. Long. 7. 14. N. Lat. 45. 19.

PRÆTORIUM (Antonine, Notitia Imperii), a town of the Brigantes. Now *Paterington* (Camden), near the mouth of the Humber in Yorkshire. *Coventry* (Talbot).

PRAGMATIC SANCTION, in the civil law, is defined by Hottoman to be a rescript or answer of the sovereign, delivered by advice of his council, to some college, order, or body of people, upon consulting him on some case of their community. The like answer given to any particular person is called simply *rescript*.

The term *pragmatic sanction* is chiefly applied to a settlement of Charles VI. emperor of Germany, who, in the year 1722, having no sons, settled his hereditary dominions on his eldest daughter the archduchess Maria Theresa, which was confirmed by the diet of the empire, and guaranteed by Great Britain, France, the States-General, and most of the powers in Europe. The word *pragmatic* is derived from the Greek πραγμα, *negotium*, "business."—It is sometimes also called absolutely *pragmatic*, το πραγματικον.

PRAGUE, a city of Bohemia, and capital of the whole kingdom, is situated 14° 40′ of longitude, and 50° 5′ of latitude. It stands on both sides the Moldau, over which there is a bridge 700 feet long, built of large freestone. The river, though of great breadth here, is nevertheless shallow, and not navigable. On both sides the bridge are several statues, and among others that of St John of Nepomuck, whom king Wensel caused to be thrown from the bridge into the river, for venturing to reprove him upon some occasion; but in 1720 he was canonized as a saint, and is at present held in such veneration in Bohemia, that all other saints seem on his account to be forgotten. Near the bridge, which stands at the upper part of the city, the number of people is very great, but the further you go from thence the more desolate you find every place. The city is about three miles long and two broad; the number of its Christian inhabitants is said to be 70,000, and of Jews about 12,000. The principal branch of its trade consists in brewing of beer. It is divided into the Old and the New Towns, and that called the *Small side*; the former lying on the east side of the Moldau, and the latter on the west. The whole is about 12 miles in circumference. The fortifications are not of great importance, as it may be flanked and raked on all sides. However, the king of Prussia was not able to make himself master of it in the late war, though he almost destroyed it with his bombs, &c. See PRUSSIA, n° 24, &c.—It hath suffered greatly by sieges, and hath been often taken and plundered. The university was founded by Charles IV. in the year 1347. In 1409, when John Huss was rector of the university, there were no less than 44,000 students; and when the emperor Charles V. would have retrenched their privileges, 24,000 are said to have left it in one week, and 16,000 in a short time after. The Jews have the trade of this city almost entirely in their own hands. They deal in all sorts of commodities, especially the precious stones found in the Bohemian mines, and, by receiving all old-fashioned things in payment, quite ruin the Christian handicraftsmen. In 1744 they narrowly escaped being expelled the kingdom, having been suspected of corresponding with the Prussians, when they made themselves masters of the city. The grand prior of the order of Malta, for Bohemia, Moravia, and Silesia, resides here; and the church and hospital of the Holy Ghost is the seat of the general and grandmasters of the holy order of knights of the cross with the red star, residing in the above-mentioned countries, and in Poland and Hungary. The houses of this city are all built of stone, and generally consist of three stories; but there are very few good buildings in it, and almost every thing looks dirty. The cathedral, which is dedicated to St Veit, is an old building, in which there are some pieces of excellent architecture and many magnificent tombs of great men. There are 100 churches and chapels, and about 40 cloisters in the place. On Ratschin-hill, in Upper Prague, most of the nobility have houses, and the emperor a very magnificent palace, and a summer-house commanding one of the finest prospects in the world. Here the tribunals of the regency meet; and the halls, galleries, and other apartments, are adorned with a multitude of noble pictures. The great hall, where the coronation feast is kept, is said to be the largest of the kind in Europe next to that of Westminster. The castle stands on the above-mentioned mountain, called *Ratschin* or the *White Mountain*, and is very strong. From a window of this castle the emperor's counsellors were thrown in 1618; but though they fell from a great height, yet they were not killed, nor indeed much hurt. On the same mountain stands also the archiepiscopal palace. In the New Town is an arsenal, and a religious foundation for ladies, called the *Free Temporal English Foundation*, over which an abbess presides. In the Lesser Side or Town, the counts Colloredo and Wallenstein have very magnificent palaces and gardens. The stables of the latter are very grand; the racks being of steel and the mangers of marble, and a marble pillar betwixt each horse; over each horse also is placed his picture as big as life. Though the inhabitants of Prague in general are poor, and their shops but meanly furnished, yet, it is said, there are few cities where the nobility and gentry are more wealthy, and live in greater state. Here is much gaming, masquerading, feasting, and very splendid public balls, with an Italian opera, and assemblies in the houses of the quality every night. On the White Mountain, near the town, was fought the battle in which the Protestants, with the elector Palatine Frederic their king, were defeated

The

The lustres and drinking-glasses made here of Bohemian crystal are much esteemed, and vended all over Europe. These crystals are also polished by the Jews, and set in rings, ear-pendants, and shirt-buttons. The chief tribunal consists of twelve stadtholders, at the head of whom is the great burgrave, governor of the kingdom and city, immediately under the emperor, and the chancery of Bohemia. Though the city of Prague is very ill-built, it is pleasantly situated, and some of the prospects are beautiful, and the gardens and pleasure-houses are excellent. The people, Riesbeck informs us, enjoy sensual pleasures more than those of Vienna, because they know better how to connect mental enjoyments with them. The numerous garrison kept in the place (9000 men) contributes much to its gaiety and liveliness.

PRAM, or PRAME, a kind of lighter used in Holland and the ports of the Baltic Sea, to carry the cargo of a merchant-ship *along-side*, in order to lade or to bring it to shore to be lodged in the storehouses after being discharged out of the vessel.

PRAME, in military affairs, a kind of floating battery, being a flat-bottomed vessel, which draws little water, mounts several guns, and is very useful in covering the disembarkation of troops. They are generally made use of in transporting troops over the lakes in America.

PRAMNION, in natural history, the name of a semipellucid gem. This is a very singular stone, and of a very great concealed beauty. Our lapidaries, when they meet with it, call it by the name of the *black agate*. It is of an extremely close, compact, and firm texture, of a smooth and equal surface, and in shape very irregular, being sometimes round, sometimes oblong, and often flat; in size it seldom exceeds two inches. It appears, on a common inspection, to be of a fine deep black; but held up against the sun or the light of a candle, it is an elegant red, clouded by a quantity of subtile black earth. We have it from the East Indies.

PRASIUM, in botany: A genus of the gymnospermia order, belonging to the didynamia class of plants; and in the natural method ranking under the 42d order, *Verticillatæ*. There are four monospermous berries.

PRATINAS, a Greek poet contemporary with Æschylus, born at Phlius. He was the first among the Greeks who composed satires, which were represented as farces. Of these 32 were acted, as also 18 of his tragedies, one of which only obtained the poetical prize. Some of his verses are extant, quoted by Athenæus.

PRATIQUE, or PRATTIC, in commerce, a negociation or communication of commerce which a merchant vessel obtains in the port it arrives in and the countries it discovers: hence to obtain a pratique, is to obtain liberty to frequent a port, to go ashore, to buy and sell, &c.

PRATT (Charles), earl of Camden, was the third son of Sir John Pratt, knight, chief-justice of the court of king's-bench under George I. by his second wife Elizabeth, daughter of the Reverend Hugh Wilson canon of Bangor, and was born in 1713, the year before his father was called to the honour of the bench. He received the first rudiments of his education at Eton, and afterwards removed to king's college Cambridge. Of his early life at both places there is little known, other than that at college he was found to be remarkably diligent and studious, and particularly so in the history and constitution of this country. By some he was thought to be a little too tenacious of the rights and privileges of the college he belonged to; but perhaps it was to this early tendency that we are indebted for those noble struggles in defence of liberty, which, whether in or out of office, he displayed through the whole course of his political life. After staying out the usual time at college, and taking his master's degree, in 1739 he entered himself a student of the Inner Temple, and was in due time admitted by that honourable society as a barrister at law. And here a circumstance developes itself in the history of this great man, which shows how much chance governs in the affairs of this world, and that the most considerable talents and indisputable integrity will sometimes require the introduction of this mistress of the ceremonies, in order to obtain that which they ought to possess from their own intrinsic qualifications.

Mr Pratt, after his being called to the bar, notwithstanding his family introduction, and his own personal character, was very near nine years in the profession, without ever getting in any degree forward. Whether this arose from a natural timidity of constitution, ill-luck, or perhaps a mixture of despondence growing out of the two circumstances, it is now difficult to tell; but the fact was so: and he was so dispirited by it, that he had some thoughts of relinquishing the profession of the law, and retiring to his college, where, in rotatation, he might be sure of a church living, that would give him a small but honourable independence. With these melancholy ideas he went as usual the western circuit, to make one more experiment, and then to take his final determination. Mr Henley, afterwards Lord Northington and chancellor of England, was in the same circuit: he was Mr Pratt's most intimate friend; and he now availed himself of that friendship, and told him his situation, and his intentions of retiring to the university and going into the church. He opposed his intention with strong raillery, and got him engaged in a cause along with himself; and Mr Henley being ill, Mr Pratt took the lead, and displayed a professional knowledge and elocution that excited the admiration of his brother barristers as much as that of the whole court. He gained his cause; and besides, he acquired the reputation of an eloquent, profound, and constitutional lawyer. It was this circumstance, together with the continued good offices of his friend Henley, which led to his future greatness; for with all his abilities and all his knowledge, he might otherwise in all probability have passed his life in obscurity unnoticed and unknown.

He became now one of the most successful pleaders at the bar, and honours and emoluments flowed thick upon him. He was chosen to represent the borough of Downton, Wilts, after the general election in 1759; recorder of Bath 1759; and the same year was appointed attorney-general; in January 1762 he was called to the degree of serjeant at law, appointed chief-justice of the common pleas, and knighted. His Lordship presided in that court with a dignity, weight, and impartiality, never exceeded by any of his predecessors; and when John Wilkes, Esq; was seized and committed to the Tower on an illegal general

Pratt.

general warrant, his Lordſhip, with the intrepidity of a Britiſh magiſtrate, and the becoming fortitude of an Engliſhman, granted him an *habeas corpus*; and on his being brought before the court of common pleas, diſcharged him from his confinement in the Tower, May 6. 1763, in a ſpeech which did him honour. His wiſe and ſpirited behaviour on this remarkable occaſion, ſo intereſting to every true-born Briton, and in the conſequent judicial proceedings between the printers of The North Briton and the meſſengers and others, was ſo acceptable to the nation, that the city of London preſented him with the freedom of their corporation in a gold box, and deſired his picture, which was put up in Guildhall, with this inſcription:

HANC ICONEM
CAROLI PRATT, EQ.
SUMMI JUDICIS C. B.
IN HONOREM TANTI VIRI,
ANGLICÆ LIBERTATIS LEGE
ASSERTORIS,
S. P. Q. L.
IN CURIA MUNICIPALI
PONI JVSSERVNT
NONO KAL. MART. A. D. MDCCLXIV.
GULIELMO BRIDGEN, AR. PRÆ. VRB.

This portrait, painted by Reynolds, was engraved by Baſire. The corporations of Dublin, Bath, Exeter, and Norwich, paid him the like compliment; and in a petition entered in the journals of the city of Dublin, it was declared, that no man appeared to have acquitted himſelf in his high ſtation with ſuch becoming zeal for the honour and dignity of the crown, and the fulfilling his majeſty's moſt gracious intentions for preſerving the freedom and happineſs of his ſubjects, and ſuch invincible fortitude in adminiſtering juſtice and law, as the Right Honourable Sir Charles Pratt, knight, the preſent lord-chief-juſtice of his majeſty's court of common pleas in England, has ſhown in ſome late judicial determinations, which muſt be remembered to his lordſhip's honour while and wherever Britiſh liberties are held ſacred.

Higher honours, however, than the breath of popular applauſe awaited Sir Charles Pratt. On the 16th of July 1765 he was created a peer of Great Britain, by the ſtyle and title of Lord Camden, Baron Camden, in the county of Kent; and, July 30. 1766, on the reſignation of Robert earl of Northington, he was appointed lord high-chancellor of Great Britain; in which capacity he, in a ſpeech of two hours, declared, upon the firſt deciſion of the ſuit againſt the meſſengers who arreſted Mr Wilkes, that "it was the unanimous opinion of the whole court, that general warrants, except in caſes of high treaſon, were illegal, oppreſſive, and unwarrantable. He conducted himſelf in this high office ſo as to obtain the love and eſteem of all parties; but when the taxation of America was in agitation, he declared himſelf againſt it, and ſtrongly oppoſing it, was removed from his ſtation in 1770.

Upon the fall of Lord North he was again taken into the adminiſtration, and on the 27th of March 1782 appointed preſident of the council; an office which he reſigned in March 1783. On the 13th of May 1786, he was created Viſcount Bayham of Bayham abbey Kent, and Earl Camden.

Whether we conſider Earl Camden as a *ſtateſman*, called to that high ſituation by his talents; as a *lawyer*, defending, ſupporting, and enlarging the conſtitution; or as a *man* ſuſtaining both by his firmneſs and unſhaken integrity—in all he excites our general praiſe; and when we contemplate his high and exalted virtue, we muſt allow him to have been an honour to his country. He died on the 18th of April 1794 at his houſe in Hill-ſtreet, Berkeley-ſquare, being at that time preſident of his majeſty's moſt honourable privy-council, a governor of the charter-houſe, recorder of the city of Bath, and F. R. S.

Pratt ‖ Prayer.

He married Elizabeth, daughter and coheir of Nicholas Jafferys, Eſq; ſon and heir of Sir Jeffery Jafferys of Brecknock priory, knight, who died in December 1779, and by whom he had iſſue John Jafferys Pratt (now Lord Camden), born 1759, M. P. for Bath, commiſſioner of the admiralty, 1782, reſigned and reappointed 1783; and four daughters, Frances, married, 1775, Robert Stewart, Eſq; of Mount Stewart, county of Down, 1779, and M. P. for that county; Elizabeth, ſingle; Sarah, married Nicholas Saintfield, Eſq; county of Down, 1779; Jane, married 1780 William Head James, Eſq; ſon and heir of Sir F. Head of Langley, county of Bucks. His ſeat at Camden place, Chiſelhurſt, was the reſidence of the great William Camden; on whoſe death it came by ſeveral intermediate owners to Weſton, Spencer, and Pratt, and was much improved by his Lordſhip. His remains were interred in the family burying-place at Seal, in Kent.

PRAXAGORAS, a native of Athens, at 19 years of age compoſed the Hiſtory of the Kings of Athens, in two books; and at 22 the Life of Conſtantine the Great, in which, though a pagan, he ſpeaks very advantageouſly of that prince. He alſo wrote the Hiſtory of Alexander the Great. He lived under Conſtantius about the year 345.

PRAXITELES, a very famous Greek ſculptor, who lived 330 years before Chriſt, at the time of the reign of Alexander the Great. All the ancient writers mention his ſtatues with a high commendation, eſpecially a Venus executed by him for the city of Cnidos, which was ſo admirable a piece, that king Nicomedes offered to releaſe the inhabitants from their tribute as the purchaſe of it; but they refuſed to part with it. The inhabitants of the iſle of Cos requeſted of Praxiteles a ſtatue of Venus; and in conſequence of this application the artiſt gave them their choice of two; one of which repreſented the goddeſs entirely naked, and the other covered with drapery. Both of theſe were of exquiſite workmanſhip; although the former was eſteemed the moſt beautiful, nevertheleſs the inhabitants of Cos had the wiſdom to give the preference to the latter, from a conviction that no motive whatever could juſtify their introducing into their city any indecent ſtatues or paintings, which are ſo likely to inflame the paſſions of young people, and lead them to immorality and vice. What a reproach will this be to many Chriſtians!—He was one of the gallants of Phryne the celebrated courteſan.

PRAYER, a ſolemn addreſs to God, which, when it is of any conſiderable length, conſiſts of *adoration*, *confeſſion*, *ſupplication*, *interceſſion*, and *thankſgiving*.

By *adoration* we expreſs our ſenſe of God's infinite perfections, his power, wiſdom, goodneſs, and mercy; and acknowledge that our conſtant dependence is upon Him by whom the univerſe was created and has been

Prayer

hitherto preserved. By *confession* is meant our acknowledgment of our manifold transgressions of the divine laws, and our consequent unworthiness of all the good things which we enjoy at present or expect to be conferred upon us hereafter. In *supplication* we intreat our omnipotent Creator and merciful Judge, not to deal with us after our iniquities, but to pardon our transgressions, and by his grace to enable us to live henceforth righteously, soberly, and godly, in this present world; and by Christians this intreaty is always made in the name and through the mediation of Jesus Christ, because to them it is known that there is none other name under heaven given unto men whereby they may be saved. To these supplications for mercy we may likewise add our prayers for the necessaries of life; because if we seek *first* the kingdom of God and his righteousness, we are assured that such things shall be added unto us. *Intercession* signifies those petitions which we offer up for others, for friends, for enemies, for all men, especially for our lawful governors, whether supreme or subordinate. And *thanksgiving* is the expression of our gratitude to God, the giver of every good and perfect gift, for all the benefits enjoyed by us and others, for the means of grace, and for the hope of glory. Such are the component parts of a regular and solemn prayer, adapted either for the church or for the closet. But an ejaculation to God, conceived on any emergency, is likewise a prayer, whether it be uttered by the voice or suffered to remain a mere affection of the mind; because the Being to whom it is addressed discerneth the thoughts of the heart.

That prayer is a duty which all men ought to perform with humility and reverence, has been generally acknowledged as well by the untaught barbarian as by the enlightened Christian; and yet to this duty objections have been made by which the understanding has been bewildered in sophistry and affronted with jargon. "If God be independent, omnipotent, and possessed of every other perfection, what pleasure, it has been asked, can he take in our acknowledgment of these perfections? If he knows all things past, present, and future, where is the propriety of our confessing our sins unto him? If he is a benevolent and merciful Being, he will pardon our sins, and grant us what is needful for us without our supplications and intreaties; and if he be likewise possessed of infinite wisdom, it is certain that no importunities of ours will prevail upon him to grant us what is improper, or for our sakes to change the equal and steady laws by which the world is governed.

"Shall burning Ætna, if a sage requires,
"Forget to thunder, and recal her fires?
"On air or sea new motions be imprest,
"Oh blameless Bethel! to relieve thy breast?
"When the loose mountain trembles from on high,
"Shall gravitation cease, if you go by?
"Or some old temple, nodding to its fall,
"For Chartres' head reserve the hanging wall*?"

* *Essay on Man.*

Such are the most plausible objections which are usually made to the practice of prayer; and though they have been set off with all the art of the metaphysical wrangler, and embellished with all the graces of the poetry of Pope, they appear to us such gross sophisms as can operate only on a very unthinking head, or on a very corrupt heart. For if God certainly exist, and there is not a mathematical theorem capable of more rigid demonstration, it is obvious that no man can think of such a being without having his mind strongly impressed with the conviction of his own constant dependence upon him; nor can he "contemplate the heavens, the work of God's hands, the moon, and the stars which he has ordained," without forming the most sublime conceptions that he can of the Divine power, wisdom, and goodness, &c. But such conviction, and such conceptions, whether clothed in words or not, are to all intents and purposes what is meant by adoration; and are as well known to the Deity while they remain the silent affections of the heart, as after they are spoken in the beginning of a prayer. Our adoration, therefore, is not expressed for the purpose of giving information to God, who understandeth our thoughts afar off; but merely, when the prayer is private, because we cannot think any more than speak without words, and because the very *sound* of words that are well chosen affects the heart, and helps to fix our attention: and as the Being who sees at once the past, present, and to come, and to whom a thousand years are but as one day, stands not in need of our information; so neither was it ever supposed by a man of rational piety, that he takes pleasure on his *own* account in hearing his perfections enumerated by creatures of yesterday; for being independent, he has no passions to be gratified, and being self-sufficient, he was as happy when existing alone as at that moment "when the morning stars sang together, and all the sons of God shouted for joy." Adoration is therefore proper only as it tends to preserve in our minds just notions of the Creator and Governor of the world, and of our own constant dependence upon him; and if such notions be useful to ourselves, who have a part to act in the scale of existence, upon which our happiness depends (a proposition which no theist will controvert), adoration must be acceptable to that benevolent God, who, when creating the world, could have no other end in view than to propagate happiness. See METAPHYSICS, n° 312.

By the same mode of reasoning, it will be easy to show the duty of *confession* and *supplication*. We are not required to confess our sins unto God, because he is ignorant of them; for he is ignorant of nothing. If he were, no reason could be assigned for our divulging to our judge actions deserving of punishment. Neither are we required to cry for mercy, in order to move him in whom there is no variableness, neither shadow of turning. The Being that made the world, governs it by laws that are inflexible, because they are the best; and to suppose that he can be induced by prayers, oblations, or sacrifices, to vary his plan of government, is an impious thought, which degrades the Deity to a level with man. One of these inflexible laws is the connection established between certain dispositions of mind and human happiness. We are enjoined to pursue a particular course of conduct under the denomination of virtue, not because our virtuous actions can in any degree be of advantage to him by whom we were created, but because they necessarily generate in our own minds those dispositions which are essential to our ultimate happiness. A man of a malignant, arrogant, or sensual disposition, would have no enjoyment in that heaven, where all are actuated by a spirit of love and purity; and it is doubtless for this reason among others, that the Christian religion prohibits

prohibits malice, arrogance, and fenfuality, among her votaries, and requires the cultivation of the oppofite virtues. But a perfon who has deviated far from his duty cannot think of returning, unlefs he be previoufly convinced that he has gone aftray. Such conviction, whenever he obtains it, will neceffarily imprefs upon his mind a fenfe of his own danger, and fill his heart with forrow and remorfe for having tranfgreffed the laws eftablifhed by the moft benevolent of all Beings for the propagation of univerfal felicity. This convicton of error, this fenfe of danger, and this compunction for having tranfgreffed, are all perceived by the Deity as foon as they take place in the mind of the finner; and he is required to *confefs* his fins, only becaufe the act of confeffion tends to imprint more deeply on his mind his own unworthinefs, and the neceffity of returning immediately into the paths of that virtue of which all the ways are pleafentnefs and all the paths are peace.

In the objection, it is taken for granted, that if God be a benevolent and merciful Being, he will pardon our fins, and grant us what is needful for us, whether we fupplicate him or not: but this is a grofs and palpable miftake, arifing from the objector's ignorance of the end of virtue and the nature of man. Until a man be fenfible of his fins and his danger, he is for the reafon already affigned incapable of pardon, becaufe his difpofition is incompatible with the happinefs of the bleffed. But whenever he acquires this conviction, it is impoffible for him not to form a *mental wifh* that he may be pardoned; and this wifh being perceptible to the all-feeing eye of his Judge, forms the fum and fubftance of a fupplication for mercy. If he clothe it in words, it is only for a reafon fimilar to that which makes him adore his Creator and confefs his fins in words, that juft notions may be more deeply imprinted on his own mind. The fame reafoning holds good with refpect to thofe prayers which we put up for temporal bleffings, for protection and fupport in our journey through life. We are told by high authority, that "the Lord is nigh unto all them that call upon him, to all that call upon him in truth." This, however, is not becaufe he is attracted or delighted by their prayers and intreaties, but becaufe thofe prayers and intreaties fit fuch as offer them for receiving thofe benefits which he is at all times ready to pour upon all mankind. In his effence God is equally prefent with the righteous and with the wicked, with thofe who pray, and with thofe who pray not; for "the eyes of the Lord are in every place beholding the evil and the good." But as the atmofphere equally furrounds every perfon upon this globe, and yet in its ftate of greateft purity does not affect the afthmatic as it affects thofe who are whole; fo the Divine prefence, though effentially the fame everywhere, yet does not protect the impious as it protects the devout, becaufe the impious are not in a ftate capable of the Divine protection. The end for which God requires the exercife of prayer as a duty, is not his benefit but ours; becaufe it is a mean to generate in the petitioner fuch a difpofition of mind as muft render him a fpecial object of that love and that providential care which extend over the whole creation.

That part of the objection which refults from the confideration of the fixed laws of nature, and which the poet has fo finely illuftrated, prefents, it muft be confeffed, confiderable difficulties; but none which to us appear infurmountable. If, indeed, we fuppofe that in the original conftitution of things, when the laws of nature were eftablifhed, a determinate duration was given to the top of the mountain and the nodding temple, without any regard to forefeen confequences, it would undoubtedly be abfurd and perhaps impious to expect the law of gravitation to be fufpended by the prayers of a good man, who fhould happen to be paffing at the inftant decreed for the fall of thefe objects. But of fuch a conftitution there is fo far from being evidence, that it appears not to be confiftent with the wifdom and goodnefs of the Author of nature. This world was undoubtedly formed for the habitation of man and of other animals. If fo, we muft neceffarily fuppofe, that in the eftablifhing of the laws of nature, God adjufted them in fuch a manner as he faw would beft ferve the accommodation of thofe fentient beings for whofe accommodation alone they were to be eftablifhed. Let it then be admitted, that all the human beings who were ever to exift upon this globe, with all their thoughts, words, and actions, were at that important moment prefent to the divine intellect, and it furely will not be impoffible to conceive, that in confequence of the forefeen danger and prayers of a good man, the determinate duration of the mountain and the tower might be either lengthened or fhortened to let him efcape. This idea of providence, and of the efficacy of prayer, is thus illuftrated by Mr Wollafton *. "Suppofe M (fome man) certainly to *foreknow*, by fome means or other, that, when he fhould come to be upon his death-bed, L would *petition* for fome *particular legacy*, in a manner fo earneft and humble, and with fuch a good difpofition, as would render it proper to grant his requeft: and upon this, M makes his *laft will*, by which he devifes to L that which was to be afked, and then locks up the *will*; and all this many years before the death of M, and whilft L had yet no expectation or thought of any fuch thing. When the time comes, the *petition* is made and *granted*; not by making any *new* will, but by the old one already made, and without alteration: which legacy had, notwithftanding that, never been left, had the petition never been preferred. The grant may be called the effect of a future act, and depends as much upon it as if it had been made after the act. So, if it had been forefeen, that L would not *fo much as afk*, and he had been therefore left out of the will, this *præterition* would have been caufed by his carriage, though much later than the date of the will. In all this nothing is hard to be admitted, if M be allowed to foreknow the cafe. And thus the *prayers* which good men offer to the *all-knowing* God, and the *neglect of prayers* by others, may find fitting effects *already* forecafted in the courfe of nature."

* *Religion of Nature delineated.*

This folution of the difficulty prefents indeed to the mind a prodigious fcheme, in which all things to come are, as it were, comprehended under one view, and eftimated and compared together. But when it is confidered what a mafs of wonders the univerfe is in other refpects; what an incomprehenfibly great and perfect Being God is; that he cannot be ignorant of any thing, no not of the future wants and deportments of particular men; and that all things which derive their exiftence from him muft be confiftent with one another—it muft furely be confeffed that fuch an adjuftment of phyfical caufes to moral volitions is within the compafs of infinite power and perfect wifdom.

To

Prayer.

To that part of a prayer which we have termed intercession, it has been objected, that "to intercede for others is to presume that we possess an interest with the Deity upon which their happiness and even the prosperity of whole communities depends." In answer to this objection, it has been observed by an ingenious and useful writer †, that "how unequal soever our knowledge of the divine economy may be to a complete solution of this difficulty, which may require a comprehension of the entire plan, and of all the ends of God's moral government, to explain it satisfactorily, we can yet understand one thing concerning it, that it is, after all, nothing more than the making of one man the instrument of happiness and misery to another; which is perfectly of a piece with the course and order that obtain, and which we must believe were intended to obtain in human affairs. Why may we not be assisted by the *prayers* of other men, as well as we are beholden for our *support to their labour?* Why may not our happiness be made in some cases to depend upon the intercession as it certainly does in many upon the good offices of our neighbours? The happiness and misery of great numbers we see oftentimes at the disposal of one man's choice, or liable to be much affected by his conduct: what greater difficulty is there in supposing, that the prayers of an individual may avert a calamity from multitudes, or be accepted to the benefit of whole communities."

† Mr Paley.

These observations may perhaps be sufficient to remove the force of the objection, but much more may be said for the practice of mutual intercession. If it be one man's duty to intercede for another, it is the duty of that other to intercede for him; and if we set aside the particular relations which arise from blood, and from particular stations in society, mutual intercession must be equally the duty of all mankind. But there is nothing (we speak from our own experience, and appeal to the experience of our readers) which has so powerful a tendency to generate in the heart of any person good-will towards another as the constant practice of praying to God for his happiness. Let a man regularly pray for his enemy with all that seriousness which devotion requires, and he will not long harbour resentment against him. Let him pray for his friend with that ardour which friendship naturally inspires, and he will perceive his attachment to grow daily and daily stronger. If, then, universal benevolence, or charity, be a disposition which we ought to cultivate in ourselves, mutual intercession is undeniably a duty, because nothing contributes so effectually to the acquisition of that spirit which an apostle terms the end of the commandment.

When it is said, that by interceding for kings, and all in authority, we seem to consider the prosperity of communities as depending upon our interest with God, the objector mistakes the nature and end of these intercessions. In the prosperity of any community consists great part of the happiness of its individual members; but that prosperity depends much upon the conduct of its governors. When, therefore, individuals intercede for their governors, the ultimate object of their prayers must be conceived to be their own good. As it is equally the duty of all the members of the community to pray for their governors, such intercessions are the prayers of the whole community for itself, and of every individual for himself. So that in this view of the case, the most just, we apprehend, that can be taken of it, it is not true that supplications and intercessions for kings and all in authority are the prayers of one individual for another, but the prayers of many individuals for that body of which each of them knows himself to be a member.

Prayer || Preadamite.

Having evinced the duty of adoration, confession, supplication, and intercession, we need not surely waste our readers time with a formal and laboured vindication of thanksgiving. Gratitude for benefits received is so universally acknowledged to be a virtue, and ingratitude is so detestable a vice, that no man who lays claim to a moral character will dare to affirm that we ought not to have a just sense of the goodness of God in preserving us from the numberless dangers to which we are exposed, and "in giving us rain from heaven, and fruitful seasons, filling our hearts with food and gladness." But if we have this sense, whether we express it in words or not, we offer to God thanksgiving; because every movement of the heart is open and exposed to his all-seeing eye.

In this article we have treated of prayer in general, and as the private duty of every individual; but there ought to be *public* as well as *private* prayer, which shall be considered afterwards. (See Worship.) We have likewise observed, that the prayers of every Christian ought to be offered in the name and through the mediation of Jesus Christ, for which the reason will be seen in the article Theology. We shall conclude our reflections on the general duty, with observing, that nothing so forcibly restrains from ill as the remembrance of a recent address to heaven for protection and assistance. After having petitioned for power to resist temptation, there is so great an incongruity in not continuing the struggle, that we blush at the thought, and persevere lest we lose all reverence for ourselves. After fervently devoting our souls to God, we start with horror at immediate apostacy: every act of deliberate wickedness is then complicated with hypocrisy and ingratitude: it is a mockery of the Father of Mercies, the forfeiture of that peace in which we closed our address, and a renunciation of the hope which that address inspired. But if prayer and immorality be thus incompatible, surely the former should not be neglected by those who contend that moral virtue is the summit of human perfection.

PREACHING. See Declamation, Art. I.—The word is derived from the Hebrew *parasch*, *exposuit*, "he expounded."

PREADAMITE, a denomination given to the inhabitants of the earth, conceived, by some people, to have lived before Adam.

Isaac de la Pereyra, in 1655, published a book to evince the reality of Preadamites, by which he gained a considerable number of proselytes to the opinion: but the answer of Demarets, professor of theology at Groningen, published the year following, put a stop to its progress; though Pereyra made a reply.

His system was this: The Jews he calls *Adamites*, and supposes them to have issued from Adam; and gives the title *Preadamites* to the Gentiles, whom he supposes to have been a long time before Adam. But this being expressly contrary to the first words of Genesis, Pereyra had recourse to the fabulous antiquities of the Egyptians and Chaldeans, and to some idle rabbins, who imagined there had been another world before that

described by Moses. He was apprehended by the inquisition in Flanders, and very roughly used, though in the service of the dauphin. But he appealed from their sentence to Rome; whither he went in the time of Alexander VII. and where he printed a retractation of his book of Preadamites. See PRE-EXISTENCE.

PREAMBLE, in law, the beginning of an act of parliament, &c. which serves to open the intent of the act, and the mischiefs intended to be remedied by it.

PREBEND, the maintenance a prebendary receives out of the estate of a cathedral or collegiate church. Prebends are distinguished into simple and dignitary: a simple prebend has no more than the revenue for its support; but a prebend with dignity has always a jurisdiction annexed to it.

PREBENDARY, an ecclesiastic who enjoys a prebend.

The difference between a prebendary and a canon is, that the former receives his prebend in consideration of his officiating in the church, but the latter merely by his being received into the cathedral or college.

PRECARIUM, in Scots law. See LAW, N° clxxiii. 9.

PRECEDENCE, a place of honour to which a person is entitled. This is either of courtesy or of right. The former is that which is due to age, estate, &c. which is regulated by custom and civility: the latter is settled by authority; and when broken in upon, gives an action at law.

In Great Britain, the order of precedency is as follows: The king; the princes of the blood; the archbishop of Canterbury; the lord high chancellor; the archbishop of York; the lord treasurer of England; the lord president of the council; the lord privy seal; dukes; the eldest sons of dukes of the blood royal; marquisses; dukes eldest sons; earls; marquisses eldest sons; dukes younger sons; viscounts; earls eldest sons; marquisses younger sons; bishops; barons; speaker of the house of commons; lord commissioner of the great seal; viscounts eldest sons; earls younger sons; barons eldest sons; privy counsellors not peers; chancellor of the exchequer; chancellor of the duchy; knights of the garter not peers; lord chief justice of the king's bench; master of the rolls; lord chief justice of the common pleas; lord chief baron of the exchequer; puisne judges and barons; knights banneret, if made in the field; masters in chancery; viscounts younger sons; barons younger sons; baronets; knights banneret; knights of the Bath; knights bachelors; baronets eldest sons; knights eldest sons; baronets younger sons; knights younger sons; field and flag officers; doctors graduate; serjeants at law; esquires; gentlemen bearing coat armour; yeomen; tradesmen; artificers; labourers.—*Note*, The ladies, except those of archbishops, bishops, and judges, take place according to the degree of quality of their husbands; and unmarried ladies take place according to that of their fathers.

PRECEDENT, in law, a case which has been determined, and which serves as a rule for all of the same nature.

PRECENTOR, a dignity in cathedrals, popularly called the *chantor*, or *master of the choir*.

PRECEPT, in law, a command in writing sent by a chief justice or justice of the peace, for bringing a person, record, or other matter before him.

Precept of Clare Constat, in Scots law. See LAW, Part III. n° clxxx. 28.

Precept of Seisin, in Scots law. See LAW, Part III. n° clxiv. 16.

PRECEPTIVE, any thing which gives or contains precepts.

Preceptive Poetry. See POETRY, n° 146, &c.

PRECESSION OF THE EQUINOXES. The most obvious of all the celestial motions is the diurnal revolution of the starry heavens. The whole appears to turn round an imaginary AXIS, which passes through two opposite points of the heavens, called the *poles*. One of these is in our sight, being very near the star and in the tail of the little bear. The great circle which is equidistant from both poles divides the heavens into the northern and southern hemispheres, which are equal. It is called the *equator*, and it cuts the horizon in the east and west points, and every star in it is 12 siderial hours above and as many below the horizon, in each revolution.

1 Diurnal revolution of the starry heavens.

The sun's motions determine the length of day and night, and the vicissitudes of the seasons. By a long series of observations, the shepherds of Asia were able to mark out the sun's path in the heavens; he being always in the opposite point to that which comes to the meridian at midnight, with equal but opposite declination. Thus they could tell the stars among which the sun then was, although they could not see them. They discovered that his path was a great circle of the heavens, afterward called the ECLIPTIC; which cuts the Equator in two opposite points, dividing it, and being divided by it, into two equal parts. They farther observed, that when the sun was in either of these points of intersection, his circle of diurnal revolution coincided with the equator, and therefore the days and nights were equal. Hence the equator came to be called the EQUINOCTIAL LINE, and the points in which it cuts the ecliptic were called the EQUINOCTIAL POINTS, and the sun was then said to be in the equinoxes. One of these was called the VERNAL and the other the AUTUMNAL EQUINOX.

2 Observations of the Asiatic shepherds.

It was evidently an important problem in practical astronomy to determine the exact moment of the sun's occupying these stations; for it was natural to compute the course of the year from that moment. Accordingly this has been the leading problem in the astronomy of all nations. It is susceptible of considerable precision, without any apparatus of instruments. It is only necessary to observe the sun's declination on the noon of two or three days before and after the equinoctial day. On two consecutive days of this number, his declination must have changed from north to south, or from south to north. If his declination on one day was observed to be 21′ north, and on the next 5′ south, it follows that his declination was nothing, or that he was in the equinoctial point about 23 minutes after 7 in the morning of the second day. Knowing the precise moments, and knowing the rate of the sun's motion in the ecliptic, it is easy to ascertain the precise point of the ecliptic in which the equator intersected it.

3 To determine the time of the sun's occupying the equinoctial points.

By a series of such observations made at Alexandria between the years 161 and 127 before Christ, Hipparchus the father of our astronomy found that the point of the autumnal equinox was about six degrees to the eastward of the star called SPICA VIRGINIS. Eager to determine

4 Hipparchus's discoveries.

Preceſſion. determine everything by multiplied obſervations, he ranſacked all the Chaldean, Egyptian, and other records, to which his travels could procure him acceſs, for obſervations of the ſame kind; but he does not mention his having found any. He found, however, ſome obſervations of Ariſtillus and Timochares made about 150 years before. From theſe it appeared evident that the point of the autumnal equinox was then about eight degrees eaſt of the ſame ſtar. He diſcuſſes theſe obſervations with great ſagacity and rigour; and, on their authority, he aſſerts that the equinoctial points are not fixed in the heavens, but move to the weſtward about a degree in 75 years or ſomewhat leſs.

5
Why called the preceſſion of the equinoxes.

This motion is called the PRECESSION OF THE EQUINOXES, becauſe by it the time and place of the ſun's equinoctial ſtation precedes the uſual calculations: it is fully confirmed by all ſubſequent obſervations. In 1750 the autumnal equinox was obſerved to be 20° 21′ weſtward of ſpica virginis. Suppoſing the motion to have been uniform during this period of ages, it follows that the annual preceſſion is about $50''\frac{1}{7}$; that is, if the celeſtial equator cuts the ecliptic in a particular point on any day of this year, it will on the ſame day of the following year cut it in a point $50''\frac{1}{7}$ to the weſt of it, and the ſun will come to the equinox 20′ 23″ before he has completed his round of the heavens. Thus the equinoctial or tropical year, or true year of ſeaſons, is ſo much ſhorter than the revolution of the ſun or the ſidereal year.

6
Importance of the diſcovery.

It is this diſcovery that has chiefly immortalized the name of Hipparchus, though it muſt be acknowledged that all his aſtronomical reſearches have been conducted with the ſame ſagacity and intelligence. It was natural therefore for him to value himſelf highly for the diſcovery. It muſt be acknowledged to be one of the moſt ſingular that has been made, that the revolution of the whole heavens ſhould not be ſtable, but its axis continually changing. For it muſt be obſerved, that ſince the equator changes its poſition, and the equator is only an imaginary circle, equidiſtant from the two poles or extremities of the axis; theſe poles and this axis muſt equally change their poſitions. The equinoctial points make a complete revolution in about 25745, the equator being all the while inclined to the ecliptic in nearly the ſame angle. Therefore the poles of this diurnal revolution muſt deſcribe a circle round the poles of the ecliptic at the diſtance of about $23\frac{1}{2}$ degrees in 25745 years; and in the time of Timochares the north pole of the heavens muſt have been 30 degrees eaſtward of where it now is.

7
Hipparchus has been accuſed of plagiariſm,

Hipparchus has been accuſed of plagiariſm and inſincerity in this matter. It is now very certain that the preceſſion of the equinoxes was known to the aſtronomers of India many ages before the time of Hipparchus. It appears alſo that the Chaldeans had a pretty accurate knowledge of the year of ſeaſons. From their ſaros we deduce their meaſure of this year to be 365 days 5 hours 49 minutes and 11 ſeconds, exceeding the truth only by 26″, and much more exact than the year of Hipparchus. They had alſo a ſidereal year of 365 days 6 hours 11 minutes. Now what could occaſion an attention to two years, if they did not ſuppoſe the equinoxes moveable? The Egyptians alſo had a knowledge of ſomething equivalent to this: for they had diſcovered that the dog-ſtar was no longer the faithful forewarner of the overflowing of the Nile; and they combined him with the ſtar Fomalhaſet* in their myſtical kalendar. This knowledge is alſo involved in the precepts of the Chineſe aſtronomy, of much older date than the time of Hipparchus.

Preceſ[...]

* See [...] pins ſi[...] zodiaq[...] des E[...] tiens, [...] de l'Ac[...] des Inſc[...] 8

But fa[...]

But all theſe acknowledged facts are not ſufficient for depriving Hipparchus of the honour of the diſcovery, or fixing on him the charge of plagiariſm. This motion was a thing unknown to the aſtronomers of the Alexandrian ſchool, and it was pointed out to them by Hipparchus in the way in which he aſcertained every other poſition in aſtronomy, namely, as the mathematical reſult of actual obſervations, and not as a thing deducible from any opinions on other ſubjects related to it. We ſee him, on all other occaſions, eager to confirm his own obſervations, and his deductions from them, by every thing he could pick up from other aſtronomers; and he even adduced the above-mentioned practice of the Egyptians in corroboration of his doctrine. It is more than probable then that he did not know any thing more. Had he known the Indian preceſſion of 54″ annually, he had no temptation whatever to withhold him from uſing it in preference to one which he acknowledges to be inaccurate, becauſe deduced from the very ſhort period of 150 years, and from the obſervations of Timochares, in which he had no great confidence.

9
Heaven[...] motion [...] counte[...] by the [...] pernica[...] ſyſtem[...]

This motion of the ſtarry heavens was long a matter of diſcuſſion, as a thing for which no phyſical reaſon could be aſſigned. But the eſtabliſhment of the Copernican ſyſtem reduced it to a very ſimple affair; the motion which was thought to affect all the heavenly bodies, is now acknowledged to be a deception, or a falſe judgment from the appearances. The earth turns round its own axis while it revolves round the ſun, in the ſame manner as we may cauſe a child's top to ſpin on the brim of a mill-ſtone, while the ſtone is turning ſlowly round its axis. If the top ſpin ſteadily, without any wavering, its axis will always point to the zenith of the heavens; but we frequently ſee, that while it ſpins briſkly round its axis, the axis itſelf has a ſlow conical motion round the vertical line, ſo that, if produced, it would ſlowly deſcribe a circle in the heavens round the zenith point. The flat ſurface of the top may repreſent the terreſtrial equator, gradually turning itſelf round on all ſides. If this top were formed like a ball, with an equatorial circle on it, it would repreſent the whole motion very prettily, the only difference being, that the ſpinning motion and this wavering motion are in the ſame direction; whereas the diurnal rotation and the motion of the equinoctial points are in contrary directions. Even this diſſimilarity may be removed, by making the top turn on a cap, like the card of a mariner's compaſs.

10
And t[...] earth's[...]

It is now a matter fully eſtabliſhed, that while the earth revolves round the ſun from weſt to eaſt, in the plane of the ecliptic, in the courſe of a year it turns round its own axis from weſt to eaſt in 23h 56′ 4″, which axis is inclined to this plane in an angle of nearly 23° 28′; and that this axis turns round a line perpendicular to the ecliptic in 25,745 years from eaſt to weſt, keeping nearly the ſame inclination to the ecliptic.—By this means, its pole in the ſphere of the ſtarry heavens deſcribes a circle round the pole of the ecliptic at the diſtance of 23° 28′ nearly. The conſequence of this muſt be, that the terreſtrial equator, when produ-

Preceffion. ced to the fphere of the ftarry heavens, will cut the ecliptic in two oppofite points, through which the fun muft pafs when he makes the day and night equal; and that thefe points muft fhift to the weftward, at the rate of $50\frac{1}{3}$ feconds annually, which is the preceffion of the equinoxes. Accordingly this has been the received doctrine among aftronomers for nearly three centuries, and it was thought perfectly conformable to appearances.

11
radley's ttempt to ifcover e parallax f the arth's orit.

But Dr Bradley, the moft fagacious of modern aftronomers, hoped to difcover the parallax of the earth's orbit by obfervations of the actual pofition of the pole of the celeftial revolution. Dr Hooke had attempted this before, but with very imperfect inftruments. The art of obferving being now prodigioufly improved, Dr Bradley refumed this inveftigation. It will eafily appear, that if the earth's axis keeps parallel to itfelf, its extremity muft defcribe in the fphere of the ftarry heavens a figure equal and parallel to its orbit round the fun; and if the ftars be fo near that this figure is a vifible object, the pole of diurnal revolution will be in different diftinguifhable points of this figure. Confequently, if the axis defcribes the cone already mentioned, the pole will not defcribe a circle round the pole of the ecliptic, but will have a looped motion along this circumference, fimilar to the abfolute motion of one of Jupiter's fatellites, defcribing an epicycle whofe centre defcribes the circle round the pole of the ecliptic.

12
ifficulties the atmpt obated by cident.

He accordingly obferved fuch an epicyclical motion, and thought that he had now overcome the only difficulty in the Copernican fyftem; but, on maturely confidering his obfervations, he found this epicycle to be quite inconfiftent with the confequences of the annual parallax, and it puzzled him exceedingly. One day, while taking the amufement of failing about on the Thames, he obferved, that every time the boat tacked, the direction of the wind, eftimated by the direction of the vane, feemed to change. This immediately fuggefted to him the caufe of his obferved epicycle, and he found it an optical illufion, occafioned by a combination of the motion of light with the motion of his telefcope while obferving the polar ftars. Thus he unwittingly eftablifhed an incontrovertible argument for the truth of the Copernican fyftem, and immortalized his name by his difcovery of the ABERRATION of the ftars.

13
is further veftigaon of the bject.

He now engaged in a feries of obfervations for afcertaining all the circumftances of this difcovery. In the courfe of thefe, which were continued for 28 years, he difcovered another epicyclical motion of the pole of the heavens, which was equally curious and unexpected. He found that the pole defcribed an epicycle, whofe diameter was about 18″, having for its centre that point of the circle round the pole of the ecliptic in which the pole would have been found independent of this new motion. He alfo obferved, that the period of this epicyclical motion was 18 years and feven months. It ftruck him, that this was precifely the period of the revolution of the nodes of the moon's orbit. He gave a brief account of thefe refults to Lord Macclesfield, then prefident of the Royal Society, in 1747. Mr Machin, to whom he alfo communicated the obfervations, gave him in return a very neat mathematical hypothefis, by which the motion might be calculated.

Plate CCCXIV

Let E (fig. 1.), be the pole of the ecliptic, and SPQ a circle diftant from it 23° 28′, reprefenting the circle defcribed by the pole of the equator during one revolution of the equinoctial points. Let P be the place of this laft mentioned pole at fome given time. Round P defcribe a circle ABCD, whofe diameter AC is 18″. The real fituation of the pole will be in the circumference of this circle; and its place, in this circumference, depends on the place of the moon's afcending node. Draw EPF and GPL perpendicular to it; let GL be the colure of the equinoxes, and EF the colure of the folftices. Dr Bradley's obfervations fhowed that the pole was in A when the node was in L, the vernal equinox. If the node recede to H, the winter folftice, the pole is in B. When the node is in the autumnal equinox at G, the pole is at C; and when the node is in F, the fummer folftice, the pole is in D. In all intermediate fituations of the moon's afcending node, the pole is in a point of the circumference ABCD, three figns or 90° more advanced.

Preceffion. 14 Mathematical theory if the poles of the equator be fuppofed to defcribe a circle.

Dr Bradley, by comparing together a great number of obfervations, found that the mathematical theory, and the calculation depending on it, would correfpond much better with the obfervations, if an ellipfe were fubftituted for the circle ABCD, making the longer axis AC 18″, and the fhorter, BD, 16″. Mr d'Alembert determined, by the phyfical theory of gravitation, the axes to be 18″ and 13″,4.

15 More exact if an ellipfe be fubftituted for the circle.

Thefe obfervations, and this mathematical theory, muft be confidered as fo many facts in aftronomy, and we muft deduce from them the methods of computing the places of all celeftial phenomena, agreeable to the univerfal practice of determining every point of the heavens by its longitude, latitude, right afcenfion, and declination.

16 Thefe obfervations and this theory are facts in aftronomy.

It is evident, in the firft place, that this equation of the pole's motion makes a change in the obliquity of the ecliptic. The inclination of the equator to the ecliptic is meafured by the arch of a great circle intercepted between their poles. Now, if the pole be in O inftead of P, it is plain that the obliquity is meafured by EO inftead of EP. If EP be confidered as the mean obliquity of the ecliptic, it is augmented by 9″ when the moon's afcending node is in the vernal equinox, and confequently the pole in A. It is, on the contrary, diminifhed 9″ when the node is in the autumnal equinox, and the pole in C; and it is equal to the mean when the node is in the colure of the folftices. This change of the inclination of the earth's axis to the plane of the ecliptic was called the NUTATION of the axis by Sir Ifaac Newton; who fhowed, that a change of nearly a fecond muft obtain in a year by the action of the fun on the prominent parts of the terreftrial fpheroid. But he did not attend to the change which would be made in this motion by the variation which obtains in the difturbing force of the MOON, in confequence of the different obliquity of her action on the equator, arifing from the motion of her own oblique orbit. It is this change which now goes by the name NUTATION, and we owe its difcovery entirely to Dr Bradley. The general change of the pofition of the earth's axis has been termed DEVIATION by modern aftronomers.

17 Obliquity of the ecliptic.

The quantity of this change of obliquity is eafily afcertained. It is evident, from what has been already faid, that when the pole is in O, the arch ADCO is equal

18 Quantity of it eafily afcertained.

Preceffion.

equal to the node's longitude from the vernal equinox, and that PM is its cofine; and (on account of the fmallnefs of AP in comparifon of EP) PM may be taken for the change of the obliquity of the ecliptic. This is therefore $=9' \times$ cof. long. node, and is additive to the mean obliquity, while O is in the femicircle BAD, that is, while the longitude of the node is from 9 figns to 3 figns; but fubtractive while the longitude of the node changes from 3 to 9 figns.

19 Change of the equinoctial points

But the nutation changes alfo the longitudes and right afcenfions of the ftars and planets by changing the equinoctial points, and thus occafioning an equation in the preceffion of the equinoctial points. It was this circumftance which made it neceffary for us to confider it in this place, while exprefsly treating of this preceffion. Let us attend to this derangement of the equinoctial points.

20 Situation of the folftitial and equinoctial colures.

The great circle or meridian which paffes through the poles of the ecliptic and equator is always the folftitial colure, and the equinoctial colure is at right angles to it: therefore when the pole is in P or in O, EP or EO is the folftitial colure. Let S be any fixed ftar or planet, and let SE be a meridian or circle of longitude; draw the circles of declination PS, OS, and the circles M′EM′, mEm', perpendicular to PE, OE.

21 Equation of longitude from nutation of the earth's axis.

If the pole were in its mean place P, the equinoctial points would be in the ecliptic meridian M′EM′, or that meridian would pafs through the interfections of the equator and ecliptic, and the angle M′ES would meafure the longitude of the ftar S. But when the pole is in O, the ecliptic meridian mEm' will pafs thro' the equinoctial points. The equinoctial points muft therefore be to the weftward of their mean place, and the equation of the preceffion muft be additive to that preceffion; and the longitude of the ftar S will now be meafured by the angle mES, which, in the cafe here reprefented, is greater than its mean longitude. The difference, or the equation of longitude, arifing from the nutation of the earth's axis, is the angle OEP, or $\frac{OM}{OE}$. OM is the fine of the angle CPO, which, by what has been already obferved, is equal to the longitude of the node: Therefore OM is equal to $9' \times$ long. node, and $\frac{OM}{OE}$ is equal to $\frac{9' \times \text{fin. long. node}}{\text{fin. obliq}^{y}\text{. eclip.}}$. This equation is additive to the mean longitude of the ftar when O is in the femicircle CBA, or while the afcending node is paffing backwards from the vernal to the autumnal equinox; but it is fubtractive from it while O is in the femicircle ADC, or while the node is paffing backwards from the autumnal to the vernal equinox; or, to exprefs it more briefly, the equation is fubtractive from the mean longitude of the ftar, while the afcending node is in the firft fix figns, and additive to it while the node is in the laft fix figns.

This equation of longitude is the fame for all the ftars, for their longitude is reckoned on the ecliptic (which is here fuppofed invariable); and therefore is affected only by the variation of the point from which the longitude is computed.

22 Right afcenfion fuffers a double change.

The right afcenfion, being computed on the equator, fuffers a double change. It is computed from, or begins at, a different point of the equator, and it terminates at a different; point becaufe the equator having changed its pofition, the circles of declination alfo change theirs. When the pole is at P, the right afcenfion of S from the folftitial colure is meafured by the angle SPE, contained between that colure and the ftar's circle of declination. But when the pole is at O, the right afcenfion is meafured by the angle SOE, and the difference of SPE and SOE is the equation of right afcenfion. The angle SOE confifts of two parts, GOE and GOS; GOE remains the fame wherever the ftar S is placed, but GOS varies with the place of the ftar.—We muft firft find the variation by which GPE becomes GOE, which variation is common to all the ftars. The triangles GPE, GOE, have a conftant fide GE, and a conftant angle G; the variation PO of the fide GP is extremely fmall, and therefore the variation of the angles may be computed by Mr Cotes's Fluxionary Theorems. See Simpfon's *Fluxions*, § 253, &c. As the tangent of the fide EP, oppofite to the conftant angle G, is to the fine of the angle EPG, oppofite to the conftant fide EG, fo is PO the variation of the fide GP, adjacent to the conftant angle, to the variation x of the angle GPO, oppofite to the conftant fide EG. This gives $x = \frac{9' \times \text{fin. long. node}}{\text{tang. obl. eclip.}}$. This is fubtractive from the mean right afcenfion for the firft fix figns of the node's longitude, and additive for the laft fix figns. This equation is common to all the ftars.

23 Other variations, &c.

The variation of the other part SOG of the angle, which depends on the different pofition of the hour circles PS and OS, which caufes them to cut the equation in different points, where the arches of right afcenfion terminate, may be difcovered as follows. The triangles SPG, SOG, have a conftant fide SG, and a conftant angle G. Therefore, by the fame Cotefian theorem, tan. SP : fin. SPG = PO : y, and y, or the fecond part of the nutation in right afcenfion, $= \frac{9'' \times \text{fin. diff. R. A. of ftar and node}}{\text{cotan. declin. ftar}}$.

24 Nutation affects the declination of the ftars.

The nutation alfo affects the declination of the ftars: For SP, the mean codeclination, is changed into SO.—Suppofe a circle defcribed round S, with the diftance SO cutting SP in f; then it is evident that the equation of declin. is $Pf =$ PO × cofine OPf = $9'' \times$ fign r. afcen. of ftar—long. of node.

25 A more exact mode of calculation.

Such are the calculations in conftant ufe in our aftronomical refearches, founded on Machin's Theory. When ftill greater accuracy is required, the elliptical theory muft be fubftituted, by taking (as is expreffed by the dotted lines) O in that point of the ellipfe defcribed on the tranfverfe axis AC, where it is cut by OM, drawn according to Machin's theory. All the change made here is the diminution of OM in the ratio of 18 to 13,4, and a correfponding diminution of the angle CPO. The detail of it may be feen in De la Lande's *Aftronomy*, art. 2874; but is rather foreign to our prefent purpofe of explaining the preceffion of the equinoxes. The calculations being in every cafe tedious, and liable to miftakes, on account of the changes of the figns of the different equations, the zealous promoters of aftronomy have calculated and publifhed tables of all thefe equations, both on the circular and elliptical hypothefis. And ftill more to abridge calculations, which occur in reducing every aftronomical obfervation, when the place of a phenomenon is deduced from a comparifon

ſon with known fixed ſtars, there have been publiſhed tables of nutation and preceſſion, for ſome hundreds of the principal ſtars, for every poſition of the moon's node and of the ſun.

26
Preceſſion of the equinoctial points, &c.

It now remains to conſider the preceſſion of the equinoctial points, with its equations, ariſing from the nutation of the earth's axis as a phyſical phenomenon, and to endeavour to account for it upon thoſe mechanical principles which have ſo happily explained all the other phenomena of the celeſtial motions.

27
Obſervations of Newton and others on this ſubject.

This did not eſcape the penetrating eye of Sir Iſaac Newton; and he quickly found it to be a conſequence, and the moſt beautiful proof, of the univerſal gravitation of all matter to all matter; and there is no part of his immortal work where his ſagacity and fertility of reſource ſhine more conſpicuouſly than in this inveſtigation. It muſt be acknowledged, however, that Newton's inveſtigation is only a ſhrewd gueſs, founded on aſſumptions, of which it would be extremely difficult to demonſtrate either the truth or falſity, and which required the genius of a Newton to pick out in ſuch a complication of abſtruſe circumſtances. The ſubject has occupied the attention of the firſt mathematicians of Europe ſince his time; and is ſtill conſidered as the moſt curious and difficult of all mechanical problems. The moſt elaborate and accurate diſſertations on the preceſſion of the equinoxes are thoſe of Sylvabella and Walmeſly, in the Philoſophical Tranſactions, publiſhed about the year 1754; that of Thomas Simpſon, publiſhed in his Miſcellaneous Tracts; that of Father Friſius, in the Memoirs of the Berlin Academy, and afterwards, with great improvements, in his Coſmographia; that of Euler in the Memoirs of Berlin; that of D'Alembert in a ſeparate diſſertation; and that of De la Grange on the Libration of the Moon, which obtained the prize in the Academy of Paris in 1769. We think the diſſertation of Father Friſius the moſt perſpicuous of them all, being conducted in the method of geometrical analyſis; whereas moſt of the others proceed in the fluxionary and ſymbolic method, which is frequently deficient in diſtinct notions of the quantities under conſideration, and therefore does not give us the ſame perſpicuous conviction of the truth of the reſults. In a work like ours, it is impoſſible to do juſtice to the problem, without entering into a detail which would be thought extremely diſproportioned to the ſubject by the generality of our readers. Yet thoſe who have the neceſſary preparation of mathematical knowledge, and wiſh to underſtand the ſubject fully, will find enough here to give them a very diſtinct notion of it; and in the article Rotation, they will find the fundamental theorems, which will enable them to carry on the inveſtigation. We ſhall firſt give a ſhort ſketch of Newton's inveſtigation, which is of the moſt palpable and popular kind, and is highly valuable, not only for its ingenuity, but alſo becauſe it will give our unlearned readers diſtinct and ſatisfactory conceptions of the chief circumſtances of the whole phenomena.

28
Sketch of Newton's inveſtigation of it.

Plate CCCXIV

Let S (fig. 2.) be the ſun, E the Earth, and M the Moon, moving in the orbit NMCDn, which cuts the plane of the Ecliptic in the line of the nodes Nn, and has one half raiſed above it, as repreſented in the figure, the other half being hid below the Ecliptic. Suppoſe this orbit folded down; it will coincide with the Ecliptic in the circle N$mcdn$. Let EX repreſent the axis of this orbit, perpendicular to its plane, and therefore inclined to the Ecliptic. Since the Moon gravitates to the ſun in the direction MS, which is all above the Ecliptic, it is plain that this gravitation has a tendency to draw the Moon towards the Ecliptic. Suppoſe this force to be ſuch that it would draw the Moon down from M to i in the time that ſhe would have moved from M to t, in the tangent to her orbit. By the combination of theſe motions, the Moon will deſert her orbit, and deſcribe the line Mr, which makes the diagonal of the parallelogram; and if no farther action of the ſun be ſuppoſed, ſhe will deſcribe another orbit M$s n'$, lying between the orbit MCDn and the Ecliptic, and ſhe will come to the Ecliptic, and paſs through it in a point n', nearer to M than n is, which was the former place of her deſcending node. By this change of orbit, the line EX will no longer be perpendicular to it; but there will be another line Ex, which will now be perpendicular to the new orbit. Alſo the Moon, moving from M to r, does not move as if ſhe had come from the aſcending node N, but from a point N′ lying beyond it; and the line of the nodes of the orbit in this new poſition is N′ n'. Alſo the angle MN′m is leſs than the angle MNm.

Thus the nodes ſhift their places in a direction oppoſite to that of her motion, or move to the weſtward; the axis of the orbit changes its poſition, and the orbit itſelf changes its inclination to the ecliptic. Theſe momentary changes are different in different parts of the orbit, according to the poſition of the line of the nodes. Sometimes the inclination of the orbit is increaſed, and ſometimes the nodes move to the eaſtward. But, in general, the inclination increaſes from the time that the nodes are in the line of ſyzigee, till they get into quadrature, after which it diminiſhes till the nodes are again in ſyzigee. The nodes advance only while they are in the octants after the quadratures, and while the moon paſſes from quadrature to the node, and they recede in all other ſituations. Therefore the receſs exceeds the advance in every revolution of the moon round the earth, and, on the whole, they recede.

What has been ſaid of one Moon, would be true of each of a continued ring of Moons ſurrounding the Earth, and they would thus compoſe a flexible ring, which would never be flat, but waved, according to the difference (both in kind and degree) of the diſturbing forces acting on its different parts. But ſuppoſe theſe Moons to cohere, and to form a rigid and flat ring, nothing would remain in this ring but the exceſs of the contrary tendencies of its different parts. Its axis would be perpendicular to its plane, and its poſition in any moment will be the mean poſition of all the axes of the orbits of each part of the flexible ring; therefore the nodes of this rigid ring will continually recede, except when the plane of the ring paſſes through the Sun, that is, when the nodes are in ſyzigee; and (ſays Newton) the motion of theſe nodes will be the ſame with the mean motion of the nodes of the orbit of one Moon. The inclination of this ring to the ecliptic will be equal to the mean inclination of the Moon's orbit during any one revolution which has the ſame ſituation of the nodes. It will therefore be leaſt of all when the nodes are in quadrature, and will increaſe till they are in ſyzigee, and then diminiſh till they are again in quadrature.

Suppoſe this ring to contract in dimenſions, the diſturbing

turbing forces will diminish in the same proportion, and in this proportion will all their effects diminish. Suppose its motion of revolution to accelerate, or the time of a revolution to diminish; the linear effects of the disturbing forces being as the squares of the times of their action, and their angular effects as the times, those errors must diminish also on this account; and we can compute what those errors will be for any diameter of the ring, and for any period of its revolution. We can tell, therefore, what would be the motion of the nodes, the change of inclination, and deviation of the axis, of a ring which would touch the surface of the earth, and revolve in 24 hours; nay, we can tell what these motions would be, should this ring adhere to the earth. They must be much less than if the ring were detached; For the disturbing forces of the ring must drag along with it the whole globe of the earth. The quantity of motion which the disturbing forces would have produced in the ring alone, will now (says Newton) be produced in the whole mass; and therefore the velocity must be as much less as the quantity of matter is greater: But still all this can be computed.

Now there is such a ring on the earth: for the earth is not a sphere, but an elliptical spheroid. Sir Isaac Newton therefore engaged in a computation of the effects of the disturbing force, and has exhibited a most beautiful example of mathematical investigation He first asserts, that the earth *must* be an elliptical spheroid, whose polar axis is to its equatorial diameter as 229 to 230. Then he demonstrates, that if the sine of the inclination of the equator be called π, and if t be the number of days (sidereal) in a year, the annual motion of a detached ring will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{4t}$. He then shows that the effect of the disturbing force on this ring is to its effect on the matter of the same ring, distributed in the form of an elliptical stratum (but still detached) as 5 to 2; therefore the motion of the nodes will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{10t}$, or $16' \; 16'' \; 24'''$ annually. He then proceeds to show, that the quantity of motion in the sphere is to that in an equatorial ring revolving in the same time, as the matter in the sphere to the matter in the ring, and as three times the square of a quadrantal arch to two squares of a diameter, jointly: Then he shows, that the quantity of matter in the terrestrial sphere is to that in the protuberant matter of the spheroid, as 52900 to 461 (supposing all homogeneous). From these premises it follows, that the motion of $16' \; 16'' \; 24'''$, must be diminished in the ratio of 10717 to 100, which reduces it to $9'' \; 07'''$ annually. And this (he says) is the precession of the equinoxes, occasioned by the action of the sun; and the rest of the $50\frac{1}{3}''$, which is the observed precession, is owing to the action of the moon, nearly five times greater than that of the sun. This appeared a great difficulty: for the phenomena of the tides show that it *cannot* much exceed twice the sun's force.

29 His determination of the form and dimensions of the earth demonstrated by M'Laurin.

Nothing can exceed the ingenuity of this process. Justly does his celebrated and candid commentator, Daniel Bernoulli, say (in his Dissertation on the Tides, which shared the prize of the French Academy with M'Laurin and Euler), that Newton saw through a veil what others could hardly discover with a microscope in the light of the meridian sun. His determination of the form and dimensions of the earth, which is the foundation of the whole process, is not offered as any thing better than a probable guess, *in re difficillima*; and it has been since demonstrated with geometrical rigour by M'Laurin.

His next principle, that the motion of the nodes of the rigid ring is equal to the mean motion of the nodes of the moon, has been most critically discussed by the first mathematicians, as a thing which could neither be proved nor refuted. Frisius has at least shown it to be a mistake, and that the motion of the nodes of the ring is double the mean motion of the nodes of a single moon; and that Newton's own principles should have produced a precession of $18\frac{1}{4}$ seconds annually, which removes the difficulty formerly mentioned.

His third assumption, that the quantity of motion of the ring must be shared with the included sphere, was acquiesced in by all his commentators, till D'Alembert and Euler, in 1749, showed that it was not the quantity of motion round an axis of rotation which remained the same, but the quantity of momentum or rotatory effort. The quantity of motion is the product of every particle by its velocity; that is, by its distance from the axis; while its momentum, or power of producing rotation, is as the square of that distance, and is to be had by taking the sum of each particle multiplied by the square of its distance from the axis. Since the earth differs so little from a perfect sphere, this makes no sensible difference in the result. It will increase Newton's precession about three-fourths of a second.

30 Examination of the phenomenon of precession on mechanical principles.

We proceed now to the examination of this phenomenon upon the fundamental principles of mechanics.

Because the mutual gravitation of the particles of matter in the solar system is in the inverse ratio of the squares of the distance, it follows, that the gravitations of the different parts of the earth to the sun or to the moon are unequal. The nearer particles gravitate more than those that are more remote.

Plate CCCCXIV.

Let $PQpE$ (fig. 3.), be a meridional section of the terrestrial sphere, and $POpq$ the section of the inscribed sphere. Let CS be a line in the plane of the ecliptic passing through the sun, so that the angle ECS is the sun's declination. Let NCM be a plane passing thro' the centre of the earth at right angles to the plane of the meridian $PQpE$; NCM will therefore be the plane of illumination.

In consequence of the unequal gravitation of the matter of the earth to the sun, every particle, such as B, is acted on by a disturbing force parallel to CS, and proportional to BD, the distance of the particle from the plane of illumination; and this force is to the gravitation of the central particle to the sun, as three times BD is to CS, the distance of the earth from the sun.

Let ABa be a plane passing through the particle B, parallel to the plane EQ of the equator. This section of the earth will be a circle, of which Aa is a diameter, and Qq will be the diameter of its section with the inscribed sphere. These will be two concentric circles, and the ring by which the section of the spheroid exceeds the section of the sphere will have AQ for its breadth; Pp is the axis of figure.

Let

Let EC be represented by the symbol - a
OC or PC - - - b
EO their difference, $=\frac{a^2-b^2}{a+b}$ - d
CL - - - x
QL - - - $\sqrt{b^2-x^2}$
The periphery of a circle to radius 1 - π
The disturbing force at the distance 1 from the plane NCM - - f
The sine of declination ECS - m
The cosine of ECS - - n

It is evident, that with respect to the inscribed sphere, the disturbing forces are completely compensated, for every particle has a corresponding particle in the adjoining quadrant, which is acted on by an equal and opposite force. But this is not the case with the protuberant matter which makes up the spheroid. The segments NS*sn* and MT*tm* are more acted on than the segments NT*tn* and MS*sm*; and thus there is produced a tendency to a conversion of the whole earth, round an axis passing through the centre C, perpendicular to the plane PQ*p*E. We shall distinguish this motion from all others to which the spheroid may be subject, by the name Libration. The axis of this libration is always perpendicular to that diameter of the equator over which the sun is, or to that meridian in which he is.

Prob. I. To determine the momentum of libration corresponding to any position of the earth respecting the sun, that is, to determine the accumulated energy of the disturbing forces on all the protuberant matter of the spheroid.

Let B and b be two particles in the ring formed by the revolution of AQ, and so situated, that they are at equal distances from the plane NM; but on opposite sides of it. Draw BD, bd, perpendicular to NM, and FLG perpendicular to LT.

Then, because the momentum, or power of producing rotation, is as the force and as the distance of its line of direction from the axis of rotation, jointly, the combined momentum of the particles B and b will be $f.\text{BD.DC}-f.bd.dc$, (for the particles B and b, are urged in contrary directions). But the momentum of B is $f.\text{BF.DC}+f.\text{FD.DC}$, and that of b is $f.b\text{G}.d\text{C}-f.d\text{G}.d\text{C}$; and the combined momentum is $f.\text{BF.D}d-f.\text{FD.}\overline{\text{DC}+d\text{C}}, =2f.\text{BF.LF}-2f.\text{LT.TC}$.

Because m and n are the sine and cosine of the angle ECS or LCT, we have $\text{LT}=m.\text{CL}$, and $\text{CT}=n.\text{CL}$, and $\text{LF}=m.\text{BL}$, and $\text{BF}=n.\text{BL}$. This gives the momentum $=2fmn\,\overline{\text{BL}^2-\text{CL}^2}$.

The breadth AQ of the protuberant ring being very small, we may suppose, without any sensible error, that all the matter of the line AQ is collected in the point Q; and, in like manner, that the matter of the whole ring is collected in the circumference of its inner circle, and that B and b now represent, not single particles, but the collected matter of lines such as AQ, which terminate at B and b. The combined momentum of two such lines will therefore be $2mnf.\text{AQ}.\overline{\text{BL}^2-\text{CL}^2}$.

Let the circumference of each parallel of latitude be divided into a great number of indefinitely small and equal parts. The number of such parts in the circumference, of which Qq is the diameter, will be $\pi\cdot\text{QL}$. To each pair of these there belongs a momentum $2mnf\,.\text{AQ}\cdot\overline{\text{BL}^2-\text{CL}^2}$. The sum of all the squares of BL, which can be taken round the circle, is one half of as many squares of the radius CL: for BL is the sine of an arch, and the sum of its square and the square of its corresponding cosine is equal to the square of the radius. Therefore the sum of all the squares of the sines, together with the sum of all the squares of the cosines, is equal to the sum of the same number of squares of the radius; and the sum of the squares of the sines is equal to the sum of the squares of the corresponding cosines: therefore the sum of the squares of the radius is double of either sum. Therefore $\int\pi\cdot\text{QL}\cdot\text{BL}^2=\frac{1}{2}\pi\cdot\text{QL.QL}^2$. In like manner the sum of the number $\pi\cdot\text{QL}$ of CL^2s will be $=\pi\cdot\text{QL}\cdot\text{CL}^2$. These sums, taken for the semicircle, are $\frac{1}{4}\pi\cdot\text{QL}\cdot\text{QL}^2$, and $\frac{1}{2}\pi\cdot\text{QL}\cdot\text{CL}^2$, or $\pi\cdot\text{QL}\cdot\frac{1}{4}\text{QL}^2$, and $\pi\cdot\text{QL}\cdot\frac{1}{2}\text{CL}^2$: therefore the momentum of the whole ring will be $2mnf\cdot\text{AQ}\cdot\text{QL}.\pi(\frac{1}{4}\text{QL}^2-\frac{1}{2}\text{CL}^2)$: for the momentum of the ring is the combined momenta of a number of pairs, and this number is $\frac{1}{2}\pi\cdot\text{QL}$.

By the ellipse we have $\text{OC}:\text{QL}=\text{EO}:\text{AQ}$, and $\text{AQ}=\text{QL}\frac{\text{EO}}{\text{OC}}, =\text{QL}\frac{d}{b}$; therefore the momentum of the ring is $2mnf\frac{d}{b}\text{QL}^2\pi\,(\frac{1}{4}\text{QL}^2-\frac{1}{2}\text{CL}^2), =mnf\frac{d}{b}\text{QL}^2\pi\,(\frac{1}{2}\text{QL}^2-\text{CL}^2)$: but $\text{QL}^2=b^2-x^2$; therefore $\frac{1}{2}\text{QL}^2-\text{CL}^2=\frac{1}{2}b^2-\frac{1}{2}x^2-x^2, =\frac{1}{2}b^2-\frac{3}{2}x^2, =\frac{b^2-3x^2}{2}$; therefore the momentum of the ring is $mnf\frac{d}{b}\pi(b^2-x^2)\left(\frac{b^2-3x^2}{2}\right)=mnf\frac{d}{b}\pi\left(\frac{b^4-4b^2x^2+3x^4}{2}\right), =mnf\frac{d}{2b}\pi\,(b^4-4b^2x^2+3x^4)$. If we now suppose another parallel extremely near to Aa, as represented by the dotted line, the distance Ll between them being $\dot{x}$, we shall have the fluxion of the momentum of the spheroid $mnf\frac{d}{2b}\pi\,(b^4\dot{x}-4b^2x^2\dot{x}+3x^4\dot{x})$; of which the fluent is $mnf\frac{d}{2b}\pi\left(b^4x-4b^2\frac{x^3}{3}+\frac{3x^5}{5}\right)$. This expresses the momentum of the zone EAaQ, contained between the equator and the parallel of latitude Aa. Now let x become $=b$, and we shall obtain the momentum of the hemispheroid $=mnf\frac{d}{2b}\pi\,(b^5-\frac{4}{3}b^5+\frac{3}{5}b^5)$, and that of the spheroid $=mnf\frac{d}{b}\pi\,(b^5-\frac{4}{3}b^5+\frac{3}{5}b^5)=\frac{4}{15}mnfd\,\pi b^4$.

This formula does not express any motion, but only a pressure tending to produce motion, and particularly tending to produce a libration by its action on the cohering matter of the earth, which is affected as a number of levers. It is similar to the common mechanical formula $w.d$, where w means a weight, and d its distance from the fulcrum of the lever.

It is worthy of remark, that the momentum of this protuberant matter is just $\frac{1}{5}$ of what it would be if it were all collected at the point O of the equator: for the matter in the spheroid is to that in the inscribed sphere as a^2 to b^2, and the contents of the inscribed sphere is $\frac{2}{3}\pi\,b^3$. Therefore $a^2:a^2-b^2=\frac{2}{3}\pi b^3:\frac{2}{3}\pi b^3\frac{a^2-b^2}{a^2}$, which is the quantity of protuberant matter. We may, without sensible error, suppose $\frac{a^2-b^2}{a}=2d$;

Preceſſion. $=2d$; then the protuberant matter will be $\frac{4}{3}\Pi b^2 d$. If all this were placed at O, the momentum would be $\frac{4}{3}\Pi d b^2 f \cdot OH \cdot HC, = \frac{4}{3} m n f d b^4$, becauſe $OH \cdot HC = m n b^2$; now $\frac{4}{3}$ is 5 times $\frac{4}{15}$.

Alſo, becauſe the ſum of all the rectangles OH·HC round the equator is half of as many ſquares of OC, it follows that the momentum of the protuberant matter placed in a ring round the equator of the ſphere or ſpheroid is one half of what it would be if collected in the point O or E; whence it follows that the momentum of the protuberant matter in its natural place is two-fifths of what it would be if it were diſpoſed in an equatorial ring. It was in this manner that Sir Iſaac Newton was enabled to compare the effect of the ſun's action on the protuberant matter of the earth, with his effect on a rigid ring of moons. The preceding inveſtigation of the momentum is nearly the ſame with his, and appears to us greatly preferable in point of perſpicuity to the fluxionary ſolutions given by later authors. Theſe indeed have the appearance of greater accuracy, becauſe they do not ſuppoſe all the protuberant matter to be condenſed on the ſurface of the inſcribed ſphere: nor were we under the neceſſity of doing this, only it would have led to very complicated expreſſions had we ſuppoſed the matter in each line AQ collected in its centre of oſcillation or gyration. We made a compenſation for the error introduced by this, which may amount to $\frac{1}{115}$ of the whole, and ſhould not be neglected, by taking d as equal to $\frac{a^2-b^2}{2a}$ inſtead of $\frac{a^2-b^2}{a+b}$. The conſequence is, that our formula is the ſame with that of the later authors.

Thus far Sir Iſaac Newton proceeded with mathematical rigour; but in the application he made two aſſumptions, or, as he calls them, hypotheſes, which have been found to be unwarranted. The firſt was, that when the ring of protuberant matter is connected with the inſcribed ſphere, and ſubjected to the action of the diſturbing force, the ſame quantity of motion is produced in the whole maſs as in the ring alone. The ſecond was, that the motion of the nodes of a rigid ring of moons is the ſame with the mean motion of the nodes of a ſolitary moon. But we are now able to demonſtrate, that it is not the quantity of motion, but of momentum, which remains the ſame, and that the nodes of a rigid ring move twice as faſt as thoſe of a ſingle particle. We proceed therefore to

31 Effects of the libratory momentum of the earth's protuberant matter.

Prob. 2. To determine the deviation of the axis, and the retrograde motion of the nodes which reſult from this libratory momentum of the earth's protuberant matter.

But here we muſt refer our readers to ſome fundamental propoſitions of rotatory motions which are demonſtrated in the article ROTATION.

If a rigid body is turning round an axis A, paſſing through its centre of gravity with the angular velocity a, and receives an impulſe which alone would cauſe it to turn round an axis B, alſo paſſing through its centre of gravity, with the angular velocity b, the body will now turn round a third axis C, paſſing thro' its centre of gravity, and lying in the plane of the axes A and B, and the ſine of the inclination of this third axis to the axis A will be to the ſine of inclination to the axis B as the velocity b to the velocity a.

32 When a rigid body is made to turn round any axis by the action of an external force, the quantity of momentum produced (that is, the ſum of the products of every particle by its velocity and by its diſtance from the axis) is equal to the momentum or ſimilar product of the moving force or forces.

If an oblate ſpheroid, whoſe equatorial diameter is a and polar diameter b, be made to librate round an equatorial diameter, and the velocity of that point of the equator which is fartheſt from the axis of libration be v, the momentum of the ſpheroid is $\frac{4}{15}\Pi a^2 b^2 v$.

The two laſt are to be found in every elementary book of mechanics.

Let AN a n (fig. 4.) be the plane of the earth's equator, cutting the ecliptic CNK n in the line of the nodes or equinoctial points N n. Let OAS be the ſection of the earth by a meridian paſſing through the ſun, ſo that the line OCS is in the ecliptic, and CA is an arch of an hour-circle or meridian, meaſuring the ſun's declination. The ſun not being in the plane of the equator, there is, by prop. 1. a force tending to produce a libration round an axis ZO z at right angles to the diameter Aa of that meridian in which the ſun is ſituated, and the momentum of all the diſturbing forces is $\frac{4}{15} m n f d \Pi b^4$. The product of any force by the moment $\dot{t}$ of its action expreſſes the momentary increment of velocity; therefore the momentary velocity, or the velocity of libration generated in the time $\dot{t}$ is $\frac{4}{15} m n f d \Pi b^4 \dot{t}$. This is the abſolute velocity of a point at the diſtance 1 from the axis, or it is the ſpace which would be uniformly deſcribed in the moment $\dot{t}$, with the velocity which the point has acquired at the end of that moment. It is double the ſpace actually deſcribed by the libration during that moment; becauſe this has been an uniformly accelerated motion, in conſequence of the continued and uniform action of the momentum during this time. This muſt be carefully attended to, and the neglect of it has occaſioned very faulty ſolutions of this problem.

Let v be the velocity produced in the point A, the moſt remote from the axis of libration. The momentum excited or produced in the ſpheroid is $\frac{4}{15}\Pi a^2 b^2 v$ (as above), and this muſt be equal to the momentum of the moving force, or to $\frac{4}{15} m n f d \Pi b^4 \dot{t}$; therefore we obtain $v = \frac{\frac{4}{15} m n f d \Pi b^4 \dot{t}}{\frac{4}{15}\Pi a^2 b^2}$, that is, $v = m n f d \dot{t} \frac{b^2}{a^2}$ or very nearly $m n f d \dot{t}$, becauſe $\frac{b^2}{a^2} = 1$ very nearly. Alſo, becauſe the product of the velocity and time gives the ſpace uniformly deſcribed in that time, the ſpace deſcribed by A in its libration round Z z is $m n f d \dot{t}^2$, and the angular velocity is $\frac{m n f d \dot{t}}{a}$.

Let $\dot{r}$ be the momentary angle of diurnal rotation. The arch A r, deſcribed by the point A of the equator in this moment $\dot{t}$ will therefore be $a\dot{r}$, that is, $a \times \dot{r}$, and the velocity of the point A is $\frac{a\dot{r}}{\dot{t}}$, and the angular velocity of rotation is $\frac{\dot{r}}{\dot{t}}$.

Here then is a body (fig. 5.) turning round an axis OP, perpendicular to the plane of the equator zoz, and therefore ſituated in the plane ZP z; and it turns round this

this axis with the angular velocity $\frac{\dot{r}}{t}$. It has received an impulfe, by which alone it would librate round the axis Z z, with the angular velocity $\frac{mnfd\dot{t}}{a}$. It will therefore turn round neither axis (n° 31.), but round a third axis OP', paffing through O, and lying in the plane ZP z, in which the other two are fituated, and the fine P'π of its inclination to the axis of libration Z z will be to the fine P'p of its inclination to the axis OP of rotation as $\frac{\dot{r}}{t}$ to $\frac{mnfd\dot{t}}{a}$.

Now A, in fig. 4. is the fummit of the equator both of libration and rotation; $mnfd\dot{t}^2$ is the fpace defcribed by its libration in the time t; and ar is the fpace or arch A r (fig. 4.) defcribed in the fame time by its rotation: therefore, taking A r to A c (perpendicular to the plane of the equator of rotation, and lying in the equator of libration), as $a\dot{r}$ to $mnfd\dot{t}^2$, and completing the parallelogram A rmc, A m will be the compound motion of A (n° 31.), and $a\dot{r} : mndf\dot{t}^2 = 1 : \frac{mnfd\dot{t}^2}{a\dot{r}}$, which will be the tangent of the angle m A r, or of the change of pofition of the equator. But the axes of rotation are perpendicular to their equator; and therefore the angle of deviation $\dot{w}$ is equal to this angle r A m. This appears from fig. 5.; for π P' : P'p = O p : P'p, = OP : tan. POP'; and it is evident that $a\dot{r} : mnfd\dot{t}^2 = \frac{\dot{r}}{t} : mnfd\frac{\dot{t}}{a}$, as is required by the compofition of rotations.

In confequence of this change of pofition, the plane of the equator no longer cuts the plane of the ecliptic in the line Nn. The plane of the new equator cuts the former equator in the line AO, and the part AN of the former equator lies between the ecliptic and the new equator AN', while the part A n of the former equator is above the new one A n'; therefore the new node N', from which the point A was moving, is removed to the weftward, or farther from A; and the new node n', to which A is approaching, is alfo moved weftward, or nearer to A; and this happens in every pofition of A. The nodes, therefore, or equinoctial points, continually fhift to the weftward, or in a contrary direction to the rotation of the earth; and the axis of rotation always deviates to the eaft fide of the meridian which paffes through the fun.

This account of the motions is extremely different from what a perfon fhould naturally expect. If the earth were placed in the fummer folftice, with refpect to us who inhabit its northern hemifphere, and had no rotation round its axis, the equator would begin to approach the ecliptic, and the axis would become more upright; and this would go on with a motion continually accelerating, till the equator coincided with the ecliptic. It would not ftop here, but go as far on the other fide, till its motion were extinguifhed by the oppofing forces; and it would return to its former pofition, and again begin to approach the ecliptic, playing up and down like the arm of a balance. On this account this motion is very properly termed *libration;* but this very flow libration, compounded with the incomparably fwifter motion of diurnal rotation, produces a third motion extremely different from both. At firft the north pole of the earth inclines forward toward the fun; after a long courfe of years it will incline to the left hand, as viewed from the fun, and be much more inclined to the ecliptic, and the plane of the equator will pafs through the fun. Then the fouth pole will come into view, and the north pole will begin to decline from the fun; and this will go on (the inclination of the equator diminifhing all the while) till, after a courfe of years, the north pole will be turned quite away from the fun, and the inclination of the equator will be reftored to its original quantity. After this the phenomena will have another period fimilar to the former, but the axis will now deviate to the right hand. And thus, although both the earth and fun fhould not move from their places, the inhabitants of the earth would have a complete fucceffion of the feafons accomplifhed in a period of many centuries. This would be prettily illuftrated by an iron ring poifed very nicely on a cap like the card of a mariner's compafs, having its centre of gravity coinciding with the point of the cap, fo that it may whirl round in any pofition. As this is extremely difficult to execute, the cap may be pierced a little deeper, which will caufe the ring to maintain a horizontal pofition with a very fmall force. When the ring is whirling very fteadily, and pretty brifkly, in the direction of the hours of a watch-dial, hold a ftrong magnet above the middle of the nearer femicircle (above the 6 hour point) at the diftance of three or four inches. We fhall immediately obferve the ring rife from the 9 hour point, and fink at the 3 hour point, and gradually acquire a motion of preceffion and nutation, fuch as has been defcribed.

If the earth be now put in motion round the fun, or the fun round the earth, motions of libration and deviation will ftill obtain, and the fucceffion of their different phafes, if we may fo call them, will be perfectly analogous to the above ftatement. But the quantity of deviation, and change of inclination, will now be prodigioufly diminifhed, becaufe the rapid change of the fun's pofition quickly diminifhes the difturbing forces, annihilates them by bringing the fun into the plane of the equator, and brings oppofite forces into action.

We fee in general that the deviation of the axis is always at right angles to the plane paffing through the fun, and that the axis, inftead of being raifed from the ecliptic, or brought nearer to it, as the libration would occafion, deviates fidewife; and the equator, inftead of being raifed or depreffed round its eaft and weft points, is twifted fidewife round the north and fouth points; or at leaft things have this appearance: but we muft now attend to this circumftance more minutely.

The compofition of rotation fhows us that this change of the axis of diurnal rotation is by no means a tranflation of the former axis (which we may fuppofe to be the axis of figure) into a new pofition, in which it again becomes the axis of diurnal motion; nor does the equator of figure, that is, the moft prominent fection of the terreftrial fpheroid, change its pofition, and in this new pofition continue to be the equator of rotation. This was indeed fuppofed by Sir Ifaac Newton; and this fuppofition naturally refulted from the train of reafoning which he adopted. It was ftrictly true of a fingle moon, or of the imaginary orbit attached to it; and therefore Newton fuppofed that the whole earth did in this manner deviate from its former pofition,

Preceffion.

tion, ftill, however, turning round its axis of figure. In this he has been followed by Walmefly, Simpfon, and moft of his commentators. D'Alembert was the firft who entertained any fufpicion that this might not be certain; and both he and Euler at laft fhowed that the new axis of rotation was really a new line in the body of the earth, and that its axis and equator of figure did not remain the axis and equator of rotation. They afcertained the pofition of the real axis by means of a moft intricate analyfis, which obfcured the connection of the different pofitions of the axis with each other, and gave us only a kind of momentary information. Father Frifius turned his thoughts to this problem, and fortunately difcovered the compofition of rotations as a general principle of mechanical philofophy. Few things of this kind have efcaped the penetrating eye of Sir Ifaac Newton. Even *this* principle had been glanced at by him. He affirms it in exprefs terms with refpect to a body that is perfectly fpherical (cor. 22. prop. 66. B. I.) But it was referved for Frifius to demonftrate it to be true of bodies of any figure, and thus to enrich mechanical fcience with a principle which gives fimple and elegant folutions of the moft difficult problems.

But here a very formidable objection naturally offers itfelf. If the axis of the diurnal motion of the heavens is not the axis of the earth's fpheroidal figure, but an imaginary line in it, round which even the axis of figure muft revolve; and if this axis of diurnal rotation has fo greatly changed its pofition, that it now points at a ftar at leaft 12 degrees diftant from the pole obferved by Timochares, how comes it that the equator has the very fame fituation on the furface of the earth that it had in ancient times? No fenfible change has been obferved in the latitudes of places.

The anfwer is very fimple and fatisfactory: Suppofe that in 12 hours the axis of rotation has changed from the pofition PR (fig. 6.) to pr, fo that the north pole, inftead of being at P, which we may fuppofe to be a particular mountain, is now at p. In this 12 hours the mountain P, by its rotation round pr, has acquired the pofition π. At the end of the next 12 hours, the axis of rotation has got the pofition $\pi\rho$, and the axis of figure has got the pofition pr, and the mountain P is now at p. Thus, on the noon of the following day, the axis of figure PR is in the fituation which the real axis of rotation occupied at the intervening midnight. This goes on continually, and the axis of figure follows the pofition of the axis of rotation, and is never further removed from it than the deviation of 12 hours, which does not exceed $\frac{1}{100}$th part of one fecond, a quantity altogether imperceptible. Therefore the axis of figure will always fenfibly coincide with the axis of rotation, and no change can be produced in the latitudes of places on the furface of the earth.

Plate CCCCXIV

34 Application of this reafoning to nutation and preceffion.

We have hitherto confidered this problem in the moft general manner; let us now apply the knowledge we have gotten of the deviation of the axis or of the momentary action of the difturbing force to the explanation of the phenomena: that is, let us fee what preceffion and what nutation will be accumulated after any given time of action.

For this purpofe we muft afcertain the precife deviation which the difturbing forces are competent to produce. This we can do by comparing the momentum of libration with the gravitation of the earth to the fun, and this with the force which would retain a body on the equator while the earth turns round its axis.

The gravitation of the earth to the fun is in the proportion of the fun's quantity of matter M directly, and to the fquare of the diftance A inverfely, and may therefore be expreffed by the fymbol $\frac{M}{A^2}$. The difturbing force at the diftance 1 from the plane of illumination is to the gravitation of the earth's centre to the fun as 3 to A, (A being meafured on the fame fcale which meafures the diftance from the plane of illumination). Therefore $\frac{3M}{A^3}$ will be the difturbing force f of our formula.

Let p be the centrifugal force of a particle at the diftance 1 from the axis of rotation; and let t and T be the times of rotation and of annual revolution, viz. fidereal day and year. Then $p : \frac{M}{A^2} = \frac{1}{t^2} : \frac{A}{T^2}$. Hence we derive $\frac{3M}{A^3} = 3p\frac{t^2}{T^2}$. But fince $\dot{r}$ was the angular velocity of rotation, and confequently $1 \times \dot{r}$ the fpace defcribed, and $\frac{1\times \dot{r}}{\dot{t}}$ the velocity; and fince the centrifugal force is as the fquare of the velocity divided by the radius, (this being the meafure of the generated velocity, which is the proper meafure of any accelerating force), we have $p = \frac{1^2 \times \dot{r}^2}{1^2 \times \dot{t}^2}, = \frac{\dot{r}^2}{\dot{t}^2}$, and $f = \frac{3\dot{r}^2}{\dot{t}^2} \times \frac{t^2}{T^2}$. Now the formula $fmnd\frac{\dot{t}^2}{a}$ expreffed the fine of the angle. This being extremely fmall, the fine may be confidered as equal to the arc which meafures the angle. Now, fubftitute for it the value now found, viz. $\frac{3\dot{r}^2}{\dot{t}^2} \times \frac{\dot{t}^2}{T^2}$, and we obtain the angle of deviation $\dot{w} = \dot{r}\frac{3t^2}{T^2}mn\frac{d}{a}$, and this is the fimpleft form in which it can appear. But it is convenient, for other reafons, to exprefs it a little differently: d is nearly equal to $\frac{a^2-b^2}{2a^2}$, therefore $\dot{w} = \dot{r} \times \frac{3}{2}\frac{t^2}{T^2}mn\frac{a^2-b_2}{a^2}$, and this is the form in which we fhall now employ it.

The fmall angle $\dot{r}\frac{3t^2}{2T^2}mn\frac{a^2-b^2}{a^2}$ is the angle in which the new equator cuts the former one. It is different at different times, as appears from the variable part mn, the product of the fine and cofine of the fun's declination. It will be a maximum when the declination is in the folftice, for mn increafes all the way to 45°, and the declination never exceeds $23\frac{1}{2}$. It increafes, therefore, from the equinox to the folftice, and then diminifhes.

Let ESL (fig. 7.) be the ecliptic, EAC the equator, BAD the new pofition which it acquires by the momentary action of the fun, cutting the former in the angle BAE $= \dot{r}\frac{3}{2}\frac{t^2}{T^2}mn\frac{a^2-b^2}{a^2}$. Let S be the fun's place in the ecliptic, and AS the fun's declination, the meridian AS being perpendicular to the equator. Let $\frac{a^2-b^2}{a^2}$ be k. The angle BAE is then $= \dot{r}\frac{3t^2}{2T^2}kmn$. In the

Prec

Preceſſion.

the ſpherical triangle BAE we have ſin. B : ſin. AE = ſin. A : ſin. BE, or = A : BE, becauſe very ſmall angles and arches are as their ſines. Therefore BE, which is the momentary preceſſion of the equinoctial point E, is equal to $A\frac{\text{ſin. AE}}{\text{ſin. B}}, = \dot{r}\times\frac{3t^2}{2T^2}kmn, \frac{\text{ſin. R. aſcenſ.}}{\text{ſin. obl. ecl.}}$

35 [Var]ious [mo]des of [app]lication.

The equator EAC, by taking the poſition BAD, recedes from the ecliptic in the colure of the ſolſtices CL, and CD is the change of obliquity or the nutation. For let CL be the ſolſtitial colure of BAD, and cl the ſolſtitial colure of EAC. Then we have ſin. B : ſin. E = ſin. LD : ſin. lc; and therefore the difference of the arches LD and lc will be the meaſure of the difference of the angles B and E. But when BE is indefinitely ſmall, CD may be taken for the difference of LD and lc, they being ultimately in the ratio of equality. Therefore CD meaſures the change of the obliquity of the ecliptic, or the nutation of the axis with reſpect to the ecliptic.

The real deviation of the axis is the ſame with the change in the poſition of the equator, Pp being the meaſure of the angle EAB. But this not being always made in a plane perpendicular to the ecliptic, the change of obliquity generally differs from the change in the poſition of the axis. Thus when the ſun is in the ſolſtice, the momentary change of the poſition of the equator is the greateſt poſſible; but being made at right angles to the plane in which the obliquity of the ecliptic is computed, it makes no change whatever in the obliquity, but the greateſt poſſible change in the preceſſion.

36 In order to find CD the change of obliquity, obſerve that in the triangle CAD, R : ſin. AC, or R : coſ. AE = ſin. A : ſin. CD, = A : CD (becauſe A and CD are exceedingly ſmall). Therefore the change of obliquity (which is the thing commonly meant by nutation) CD = A × coſ. AE, $=\dot{r}\frac{3t^2}{2T^2}kmn$, coſ. AE $=\dot{r}\frac{3t^2}{2T^2}k$ × ſin. declin. × coſ. declin. × coſ. R. aſcenſ.

37 But it is more convenient for the purpoſes of aſtronomical computation to make uſe of the ſun's longitude SE. Therefore make

The ſun's longitude ES		$= z$
Sine of ſun's long.		$= x$
Coſine	$\sqrt{1-x^2}$	$= y$
Sine obliq. eclipt.	$23\frac{1}{2}$	$= p$
Coſine obliq.		$= q$

38 In the ſpherical triangle EAS, right angled at A (becauſe AS is the ſun's declination perpendicular to the equator), we have R : ſin. ES = ſin. E : ſin. AS, and ſin. AS $= px$. Alſo R : coſ. AS = coſ. AE : coſ. ES, and coſ. ES or y = coſ. AS × coſ. AE. Therefore pxy = ſin. AS × coſ. AS × coſ. AE, $= mn$ × coſ. AE. Therefore the momentary nutation CD $=\dot{r}\times\frac{3t^2}{2T^2}kpxy$.

39 We muſt recollect that this angle is a certain fraction of the momentary diurnal rotation. It is more convenient to conſider it as a fraction of the ſun's annual motion, that ſo we may directly compare his motion on the ecliptic with the preceſſion and nutation correſponding to his ſituation in the heavens. This change is eaſily made, by augmenting the fraction in the ratio of the ſun's angular motion to the motion of rotation, or multiplying the fraction by $\frac{T}{t}$; therefore the momentary nutation will be $\dot{r}\frac{3t}{2T}kpxy$. In this value $\frac{3tkp}{2T}$ is a conſtant quantity, and the momentary nutation is proportional to xy, or to the product of the ſine and coſine of the ſun's longitude, or to the ſine of twice the ſun's longitude; for xy is equal to half the ſine of twice z.

If therefore we multiply this fraction by the ſun's momentary angular motion, which we may ſuppoſe, with abundant accuracy, proportional to $\dot{z}$, we obtain the fluxion of the nutation, the fluent of which will expreſs the whole nutation while the ſun deſcribes the arch z of the ecliptic, beginning at the vernal equinox. Therefore, in place of y put $\sqrt{1-x^2}$, and in place of $\dot{z}$ put $\frac{\dot{x}}{\sqrt{1-x^2}}$, and we have the fluxion of the nutation for the moment when the ſun's longitude is z, and the fluent will be the whole nutation. The fluxion reſulting from this proceſs is $\frac{3tkp}{2T}x\dot{x}$, of which the fluent is $\frac{3tkp}{4T}x^2$. This is the whole change produced on the obliquity of the ecliptic while the ſun moves along the arch z ecliptic, reckoned from the vernal equinox. When this arch is 90°, x^2 is 1, and therefore $\frac{3tkp}{4T}$ is the nutation produced while the ſun moves from the equinox to the ſolſtice. 40

The momentary change of the axis and plane of the equator (which is the meaſure of the changing force) is $\frac{3tk}{2T}mn$. 41

The real and momentary changes greateſt at the ſolſtices, and at the equinoxes, nothing.

The momentary change of the obliquity of the ecliptic is $\frac{3tkp}{2T}x\dot{x}$

The whole change of obliquity is $\frac{3tkp}{4T}x^2$.

Hence we ſee that the force and the real momentary change of poſition are greateſt at the ſolſtices, and diminiſh to nothing in the equinoxes.

The momentary change of obliquity is greateſt at the octants, being proportional to $x\dot{x}$ or to xy

The whole accumulated change of obliquity is greateſt at the ſolſtices, the obliquity itſelf being then ſmalleſt. 42

Quantity of preceſſion in a given time.

We muſt in like manner find the accumulated quantity of the preceſſion after a given time, that is, the arch BE for a finite time.

We have ER : CD = ſin. EA : ſin. CA (or coſ. EA) = tan. EA : 1, and EB : ER = 1 : ſin. B. Therefore EB : CD = tan. EA : ſin. B. But tan. EA = coſ. E × tan. ES, = coſ. E × $\frac{\text{ſin. long.}}{\text{coſ. long.}} = \frac{qx}{\sqrt{1-x^2}}$.

Therefore EB : CD $= \frac{qx}{\sqrt{1-x^2}}p$, and CD = EB : $\frac{\text{ſin. obliq. eclip.}}{\text{tan. long. ☉}}$. If we now ſubſtitute for CD its value found in n° 40. viz. $\frac{3tkp}{2T}x\dot{x}$, we obtain EB $= \frac{3t}{2T}\times\frac{kqx^2\dot{x}}{\sqrt{1-x^2}}$, the fluxion of the preceſſion of the equi-

Preceſſion. equinoxes occaſioned by the action of the ſun. The fluent of the variable part $\frac{x^2\dot{x}}{\sqrt{1-x^2}} = x\dot{y}$, of which the fluent is evidently a ſegment of a circle whoſe arch is z and ſine x, that is, $= \frac{z-x\sqrt{1-x^2}}{2}$, and the whole preceſſion, while the ſun deſcribes the arch z, is $\frac{3t}{2T}\times\frac{kq}{2}\left(z-x\sqrt{1-x^2}.\right)$ This is the preceſſion of the equinoxes while the ſun moves from the vernal equinox along the arch z of the ecliptic.

In this expreſſion, which conſiſts of two parts, $\frac{3tkq}{4T}z$, and $\frac{3tkq}{4T}\left(-x\sqrt{1-x^2}\right)$, the firſt is incomparably greater than the ſecond, which never exceeds 1″, and is always compenſated in the ſucceeding quadrant. The preceſſion occaſioned by the ſun will be $\frac{3tkq}{4T}z$, and from this expreſſion we ſee that the preceſſion increaſes uniformly, or at leaſt increaſes at the ſame rate with the ſun's longitude z, becauſe the quantity $\frac{3tkq}{4T}$ is conſtant.

43 Mode of uſing the formulæ. In order to make uſe of theſe formulæ, which are now reduced to very great ſimplicity, it is neceſſary to determine the values of the two conſtant quantities $\frac{3tkp}{4T}$, $\frac{3tkq}{4T}$, which we ſhall call N and P, as factors of the nutation and preceſſion. Now t is one ſidereal day, and T is $366\frac{1}{4}$. k is $\frac{a^2-b^2}{a^2}$, which according to Sir Iſaac Newton is $\frac{231^2-230^2}{231^2} = \frac{1}{115}$; p and q are the ſine and coſine of 23° 28′, viz. 0,39822 and 0,91729.

Theſe data give $N = \frac{1}{141030}$ and $P = \frac{1}{61224}$ of which the logarithms are 4.85069 and $\bar{5}$.21308, viz. the arithmetical complements of 5.14931 and 4.78692.

44 Example of the utility of the inveſtigation. Let us, for an example of the uſe of this inveſtigation, compute the preceſſion of the equinoxes when the ſun has moved from the vernal equinox to the ſummer ſolſtice, ſo that z is 90°, or 324000′.

Log 324000′ = z	5.51055
Log P	$\bar{5}$.21308
Log 5″,292	0.72363

The preceſſion therefore in a quarter of a year is 5,292 ſeconds; and, ſince it increaſes uniformly, it is 21″,168 annually.

45 Aſſumptions on which the computation proceeds. We muſt now recollect the aſſumptions on which this computation proceeds. The earth is ſuppoſed to be homogeneous, and the ratio of its equatorial diameter to its polar axis is ſuppoſed to be that of 231 to 230. If the earth be more or leſs protuberant at the equator, the preceſſion will be greater or leſs in the ratio of this protuberance. The meaſures which have been taken of the degrees of the meridian are very inconſiſtent among themſelves; and although a compariſon of them all indicates a ſmaller protuberancy, nearly $\frac{1}{171}$ inſtead of $\frac{1}{231}$, their differences are too great to leave much confidence in this method. But if this figure be thought more probable, the preceſſion will be reduced to about 17″ annually. But even though the figure of the earth were accurately determined, we have no authority to ſay that it is homogeneous. If it be denſer towards the centre, the momentum of the protuberant matter will not be ſo great as if it were equally denſe with the inferior parts, and the preceſſion will be diminiſhed on this account. Did we know the proportion of the matter in the moon to that in the ſun, we could eaſily determine the proportion of the whole obſerved annual preceſſion of $50\frac{1}{3}$″ which is produced by the ſun's action. But we have no unexceptionable data for determining this; and we are rather obliged to infer it from the effect which ſhe produces in diſturbing the regularity of the preceſſion, as will be conſidered immediately. So far, therefore, as we have yet proceeded in this inveſtigation, the reſult is very uncertain. We have only aſcertained unqueſtionably the law which is obſerved in the ſolar preceſſion. It is probable, however, that this preceſſion is not very different from 20″ annually; for the phenomena of the tides ſhow the diſturbing force of the ſun to be very nearly $\frac{2}{5}$ of the diſturbing force of the moon. Now 20″ is $\frac{2}{5}$ of 50″.

But let us now proceed to conſider the effect of the moon's action on the protuberant matter of the earth; and as we are ignorant of her quantity of matter, and conſequently of her influence in ſimilar circumſtances with the ſun, we ſhall ſuppoſe that the diſturbing force of the moon is to that of the ſun as m to 1. Then 46 Effect of the moon's action on the protuberant matter of the earth.
(cæteris paribus) the preceſſion will be to the ſolar preceſſion π in the ratio of the force and of the time of its action jointly. Let t and T therefore repreſent a periodical month and year, and the lunar preceſſion will be $=\frac{m\pi t}{T}$. This preceſſion muſt be reckoned on the plane of the lunar orbit, in the ſame manner as the ſolar preceſſion is reckoned on the ecliptic. We muſt alſo obſerve, that $\frac{m\pi t}{T}$ repreſents the lunar preceſſion only on the ſuppoſition that the earth's equator is inclined to the lunar orbit in an angle of $23\frac{1}{2}$ degrees. This is indeed the mean inclination; but it is ſometimes increaſed to above 28°, and ſometimes reduced to 18°. Now in the value of the ſolar preceſſion the coſine of the obliquity was employed. Therefore whatever is the angle E contained between the equator and the lunar orbit, the preceſſion will be $=\frac{m\pi t}{T}\cdot\frac{\text{Coſ. E}}{\text{Coſ. }23\frac{1}{2}^\circ}$, and it muſt be reckoned on the lunar orbit.

Now let ♈B (fig. 8.) be the immoveable plane of the ecliptic, ♈ED♎F the equator in its firſt ſituation, before it has been deranged by the action of the moon, AGRDBH the equator in its new poſition, after the momentary action of the moon. Let EGNFH be the moon's orbit, of which N is the aſcending node, and the angle N = 5° 8′ 46″. 47

Let N♈ the long. of the node be	z
Sine N♈	x
Coſine N♈	y
Sine ♈ = $23\frac{1}{2}$	a
Coſine ♈	b
Sine N = 5.8.46	c
Coſine N	d
Circumference to radius 1, = 6,28	e

Force

ecession.

Force of the moon - - m
Solar precession (supposed $= 14\frac{1}{2}''$ by observation) - - - π
Revolution of ☾ $= 27^{d}\frac{1}{3}$ - - t
Revolution of ☉ $= 366\frac{1}{4}$ - - T
Revolution of N $=$ 18 years 7 months - n

48
ar precion in a nth reed to ecliptic.

In order to reduce the lunar precession to the ecliptic, we must recollect that the equator will have the same inclination at the end of every half revolution of the sun or of the moon, that is, when they pass through the equator, because the sum of all the momentary changes of its position begins again each revolution. Therefore if we neglect the motion of the node during one month, which is only $1\frac{1}{2}$ degrees, and can produce but an insensible change, it is plain that the moon produces, in one half revolution, that is, while she moves from H to G, the greatest difference that she can in the position of the equator. The point D, therefore, half-way from G to H, is that in which the moveable equator cuts the primitive equator, and DE and DF are each 90°. But S being the solstitial point, ♈S is also 90°. Therefore DS $=$ ♈E. Therefore, in the triangle DGE, we have sin. ED : sin. G $=$ sin. EG : sin. D, $=$ EG : D. Therefore D $=$ EG $\times$ sin. G, $=$ EG $\times$ sin. E nearly. Again, in the triangle ♈DA we have sin. A : sin. ♈D (or cos. ♈E) $=$ sin. D : sin. ♈A, $=$ D : ♈A. Therefore ♈A $= \frac{\text{D} \cdot \text{Cos. ♈E}}{\text{Sin. A}}$, $= \frac{\text{EG} \cdot \text{Sin. E} \cdot \text{Cos. ♈E}}{\text{Sin. } 23\frac{1}{2}}$, $=$ $\frac{m\,\pi\,t}{\text{T}}$ $\frac{\text{Sin. E} \cdot \text{Cos. E} \cdot \text{Cos. ♈E}}{\text{Sin. ♈} \cdot \text{Cos. ♈}}$.

49 This is the lunar precession produced in the course of one month, estimated on the ecliptic, not constant like the solar precession, but varying with the inclination or the angle E or F, which varies both by a change in the angle N, and also by a change in the position of N on the ecliptic.

50
tation in same e,

We must find in like manner the nutation SR produced in the same time, reckoned on the colure of the solstices RL. We have R : sin. DS $=$ D : RS, and RS $=$ D $\cdot$ sin. DS, $=$ D $\cdot$ sin. ♈E. But D $=$ EG $\cdot$ sin. E. Therefore RS $=$ EG $\cdot$ sin. E $\cdot$ sin. ♈E, $= \frac{m\,\pi\,t \text{ Cos. E}}{\text{T} \cdot \text{Cos. ♈}}$ $\times$ sin. E $\times$ sin. ♈E. In this expression we must substitute the angle N, which may be considered as constant during the month, and the longitude ♈N, which is also nearly constant, by observing that sin. E : sin. ♈N $=$ sin. N : sin. ♈E. Therefore RS $= \frac{m\pi t}{\text{T}} \times \frac{\text{Sin. N} \cdot \text{Sin. ♈N} \cdot \text{Cos. E.}}{\text{Cos. ♈}}$ But we must exterminate the angle E, because it changes by the change of the position of N. Now, in the triangle ♈EN we have cos. E $=$ cos. ♈N $\cdot$ sin. N $\cdot$ sin. ♈ $-$ cos. N $\cdot$ cos. ♈, $= yca - db$. And because the angle E is necessarily obtuse, the perpendicular will fall without the triangle, the cosine of E will be negative, and we shall have cos. E $= bd - acy$. Therefore the nutation for one month will be $= \frac{m\,\pi\,t}{\text{T}} \times \frac{c\,x(b\,d - a\,c\,y)}{b}$, the node being supposed all the while in N.

51
ay be sidered momeny parts the on's acn.

These two expressions of the monthly precession and nutation may be considered as momentary parts of the moon's action, corresponding to a certain position of the node and inclination of the equator, or as the fluxions of the whole variable precession and nutation, while the node continually changes its place, and in the space of 18 years makes a complete tour of the heavens.

Precession.

52
Precession and nutation compared.

We must, therefore, take the motion of the node as the fluent of comparison, or we must compare the fluxions of the node's motion with the fluxions of the precession and nutation; therefore, let the longitude of the node be z, and its monthly change $= \dot{z}$; we shall then have $t : n = \dot{z} : e$, and $t = \frac{n\dot{z}}{e}$, $= \frac{n\,\dot{x}}{e\sqrt{1-x^2}}$. Let T be $= 1$, in order that n may be 18,6, and substitute for t its value in the fluxion of the nutation, by putting $\sqrt{1-x^2}$ in place of y. By this substitution we obtain $m\,\pi\,n\frac{c}{e\,b}$ $\left(\frac{d\,b\,x\,\dot{x}}{\sqrt{1-x^2}} - a\,c\,x\,\dot{x}\right)$. The fluent of this is $m\,\pi\,n\frac{c}{e\,b}$ $\left(-d\,b\sqrt{1-x^2} - \frac{a\,c\,x^2}{2}\right)$. (*Vide* Simpson's Fluxions, § 77). But when x is $= o$, the nutation must be $= o$, because it is from the position in the equinoctial points that all our deviations are reckoned, and it is from this point that the periods of the lunar action recommences. But if we make $x = o$ in this expression, the term $-\frac{a\,c\,x^2}{2}$ vanishes, and the term $-d\,b\sqrt{1-x^2}$ becomes $= -d\,b$; therefore our fluent has a constant part $+ db$; and the complete fluent is $m\pi n\frac{c}{eb}\left(d\,b - db\sqrt{1-x^2} - \frac{a\,c\,x^2}{2}\right)$. Now this is equal to $m\,\pi\,n\frac{c}{e\,b}(d\,b \times$ versed sine, $z - \frac{1}{4}\,a\,c \times$ versed sine $2\,z)$: For the versed sine of z is equal to $(1 -$ cos. $z)$; and the square of the sine of an arch is $\frac{1}{2}$ the versed sine of twice that arch.

This, then, is the whole nutation while the moon's ascending node moves from the vernal equinox to the longitude ♈N $= z$. It is the expression of a certain number of seconds, because π, one of its factors, is the solar precession in seconds; and all the other factors are numbers, or fractions of the radius 1; even e is expressed in terms of the radius 1. 53

The fluxion of the precession, or the monthly precession, is to that of the nutation as the cotangent of ♈E is to the sine of ♈. This also appears by considering figure 7. Pp measures the angle A, or change of position of the equator; but the precession itself, reckoned on the ecliptic, is measured by Po, and the nutation by $p\,o$; and the fluxion of the precession is equal to the fluxion of nutation $\times \frac{\text{cot. ♈E}}{\text{sine ♈}}$, but cot. ♈E $= \frac{a\,d + b\,c\,y}{c\,x}$; therefore $\frac{\text{cot. ♈E}}{\text{sine ♈}} = \frac{a\,d + b\,c\sqrt{1-x^2}}{c\,x}$: This, multiplied into the fluxion of the nutation, gives $\frac{m\,\pi\,n}{a\,b\,e}\left(\frac{a\,b\,d^2}{\sqrt{1-xx}} + (b^2 - a^2)\,d\,c - a\,b\,c^2.\sqrt{1-xx}\right)\dot{x}$ for the monthly precession. The fluent of this $\frac{m\,\pi\,n}{a\,b\,e}\left(a\,d^2\,b\,z + (b^2 - a^2)\,d\,c\,x - \frac{1}{2}\,a\,b\,c^2\,z - \frac{1}{2}\,a\,b\,c^2\,x\sqrt{1-x^2}\right)$, or it is equal to $\frac{m\,\pi\,n}{a\,b\,e}\left((d^2 - \frac{1}{2}c^2)\,a\,b\,z + (b^2 - a^2)\,d\,c\,z - \frac{1}{4}\,a\,b\,c^2 \text{ sine } 2z\right)$. 54

Let

Precession.

55 Let us now expreſs this in numbers: When the node has made a half revolution, we have $z=180°$, whoſe verſed ſine is 2, and the verſed ſine of $2z$, or 360°, is $=0$; therefore, after half a revolution of the node, the nutation (n° 52.) becomes $\frac{m\pi nc}{eb}2bd$. If, in this expreſſion, we ſuppoſe $m=2\frac{1}{2}$, and $\pi=14\frac{1}{2}''$, we ſhall find the nutation to be $19\frac{1}{5}''$.

56 Now the obſerved nutation is about 18″. This requires m to be $2\frac{1}{10}$, and $\pi=16\frac{1}{4}''$. But it is evident, that no aſtronomer can pretend to warrant the accuracy of his obſervations of the nutation within 1″.

To find the lunar preceſſion during half a revolution of the node, obſerve, that then z becomes $=\frac{e}{2}$, and the ſine of z and of $2z$ vaniſh, d^2 becomes $1-c^2$, and the preceſſion becomes $\frac{m\pi n}{2}(d^2-\frac{1}{2}c^2)$, $=\frac{m\pi n}{2}(1-\frac{3}{2}c^2)$, and the preceſſion in 18 years is $m\pi n\,\overline{1-\frac{3}{2}c^2}$.

57 We ſee, by comparing the nutation and preceſſion for nine years, that they are as $\frac{4cd}{e}$ to $1-\frac{3}{2}c^2$ nearly as 1 to $17\frac{1}{3}$. This gives 313″ of preceſſion, correſponding to 18″, the obſerved nutation, which is about 35″ of preceſſion annually produced by the moon.

58 Gives the diſturbing force and matter of the moon.

And thus we ſee, that the inequality produced by the moon in the preceſſion of the equinoxes, and, more particularly, the nutation occaſioned by the variable obliquity of her orbit, enables us to judge of her ſhare in the whole phenomenon; and therefore informs us of her diſturbing force, and therefore of her quantity of matter. This phenomenon, and thoſe of the tides, are the only facts which enable us to judge of this matter: and this is one of the circumſtances which has cauſed this problem to occupy ſo much attention. Dr Bradley, by a nice compariſon of his obſervations with the mathematical theory, as it is called, furniſhed him by Mr Machin, found that the equation of preceſſion computed by that theory was too great, and that the theory would agree better with the obſervations, if an ellipſe were ſubſtituted for Mr Machin's little circle. He thought that the ſhorter axis of this ellipſe, lying in the colure of the ſolſtices, ſhould not exceed 16″. Nothing can more clearly ſhow the aſtoniſhing accuracy of Bradley's obſervations than this remark: for it reſults from the theory, that the pole muſt really deſcribe an ellipſe, having its ſhorter axis in the ſolſtitial colure, and the ratio of the axes muſt be that of 18 to 16,8; for the mean preceſſion during a half revolution of the node is $\frac{m\pi n}{2}(d^2-\frac{c^2}{2})$; and therefore, for the longitude z, it will be $\frac{zm\pi n}{e}(d^2-\frac{c^2}{2})$; when this is taken from the true preceſſion for that longitude (n° 54.), it leaves the equation of preceſſion $\frac{m\pi n}{abe}\left((b^2-a^2)\,dc\cdot\text{ſine }z-\frac{1}{4}abc\text{ ſine }2z\right)$; therefore, when the node is in the ſolſtice, and the equation greateſt, we have it $=\frac{m\pi ncd}{abe}(b^2-a^2)$. We here neglect the ſecond term as inſignificant.

59 Greateſt equation of preceſſion.

This greateſt equation of preceſſion is to $\frac{2m\pi ncd}{6}$, the nutation of 18″, as b^2-a^2 to $2ab$; that is, as radius to the tangent of twice the obliquity of the ecliptic. This gives the greateſt equation of preceſſion 16″,8, not differing half a ſecond from Bradley's obſervations.

Preceſſion || Predeſtination.

Thus have we attempted to give ſome account of this curious and important phenomenon. It is curious, becauſe it affects the whole celeſtial motions in a very intricate manner, and received no explanation from the more obvious application of mechanical principles, which ſo happily accounted for all the other appearances. It is one of the moſt illuſtrious proofs of Sir Iſaac Newton's ſagacity and penetration, which catched at a very remote analogy between this phenomenon and the libration of the moon's orbit. It is highly important to the progreſs of practical and uſeful aſtronomy, becauſe it has enabled us to compute tables of ſuch accuracy, that they can be uſed with confidence for determining the longitude of a ſhip at ſea. This alone fixes its importance: but it is ſtill more important to the philoſopher, affording the moſt inconteſtable proof of the univerſal and mutual gravitation of all matter to all matter. It left nothing in the ſolar ſyſtem unexplained from the theory of gravity but the acceleration of the moon's mean motion; and this has at laſt been added to the liſt of our acquſitions by Mr de la Place.

Quæ toties animos veterum torſere Sophorum,
Quæque ſcholas fruſtra rauco certamine vexant,
Obvia conſpicimus, nube pellente Matheſi,
Jam dubios nulla caligine prægravat error
Queis ſuperûm penetrare domos, atque ardua cœli
Scandere ſublimis genii conceſſit acumen.
Nec fas eſt propius mortali attingere divos.

Halley.

PRECIÆ, (*precius*, "early,)") the name of the 21ſt order in Linnæus's fragments of a natural method; conſiſting of primroſe, an early flowering plant, and a few genera which agree with it in habit and ſtructure, though not always in the character or circumſtance expreſſed in the title. See BOTANY, p. 461. col. 2.

PRECIPITANT, in chemiſtry, is applied to any liquor, which, when poured on a ſolution, ſeparates what is diſſolved, and makes it precipitate, or fall to the bottom of the veſſel.

PRECIPITATE, in chemiſtry, a ſubſtance which, having been diſſolved in a proper menſtruum, is again ſeparated from its ſolvent, and thrown down to the bottom of the veſſel, by pouring ſome other liquor upon it.

PRECIPITATION. See *CHEMISTRY-Index*.

PRECOGNITION, in Scots law. See LAW, Part III. n° CLXXXVI. 43.

PRECORDIA, in anatomy, a general name for the parts ſituated about the heart, in the forepart of the thorax: as the diaphragm, pericardium, and even the heart itſelf, with the ſpleen, lungs, &c.

PREDECESSOR, properly ſignifies a perſon who has preceded or gone before another in the ſame office or employment; in which ſenſe it is diſtinguiſhed from anceſtor.

PREDESTINATION, the decree of God, whereby he hath from all eternity unchangeably appointed whatſoever comes to paſs; and hath more eſpecially fore-ordained certain individuals of the human race to everlaſting

1 The doctrine ſtated.

everlaſting happineſs, and hath paſſed by the reſt, and fore-ordained them to everlaſting miſery. The former of theſe are called the *elect*, and the latter are called the *reprobate*.

2 This doctrine is the ſubject of one of the moſt perplexing controverſies that has occurred among mankind. But it is not altogether peculiar to the Chriſtian faith. The opinion, that whatever occurs in the world at large, or in the lot of private individuals, is the reſult of a previous and unalterable arrangement by that Supreme Power which preſides over nature, has always been a favourite opinion among the vulgar, and has been believed by many ſpeculative men. Thus, in that beautiful ſcene in the ſixth book of the Iliad, Hector, taking leave of his wife and his child, ſpeaks thus:

> Andromache! my ſoul's far better part,
> Why with untimely ſorrows heaves thy heart?
> No hoſtile hand can antedate my doom,
> Till fate condemns me to the ſilent tomb.
> Fix'd is the term to all the race of earth,
> And ſuch the hard condition of our birth.
> No force can then reſiſt, no flight can ſave,
> All ſink alike, the fearful and the brave. l. 624.

The ancient Stoics, Zeno and Chryſippus, whom the Jewiſh Eſſenes ſeem to have followed, aſſerted the exiſtence of a Deity that, acting wiſely, but neceſſarily, contrived the general ſyſtem of the world; from which, by a ſeries of cauſes, whatever is now done in it unavoidably reſults. This ſeries, or concatenation of cauſes, they held to be neceſſary in every part; and that God himſelf is ſo much the ſervant of neceſſity, and of his own decrees, that he could not have made the ſmalleſt object in the world otherwiſe than it now is, much leſs is he able to alter any thing.

According to the words of Seneca, *Eadem neceſſitas et Deos alligat. Irrevocabilis divina pariter atque humana curſus vehit. Ille ipſe omnium conditor ac rector ſcripſit quidem fata ſed ſequitur. Semper paret, ſemel juſſit.* "The ſame chain of neceſſity conſtrains both gods and men. Its unalterable courſe regulates divine as well as human things. Even he who wrote the Fates, the Maker and Governor of all things, ſubmits to them. He did but once command, but he always obeys." The ſtoical fate differs, however, from the Chriſtian predeſtination in ſeveral points. They regarded the divine nature and will as a neceſſary part of a neceſſary chain of cauſes; whereas the Chriſtians conſider the Deity as the Lord and Ruler of the Univerſe, omnipotent and free, appointing all things according to his pleaſure. Being doubtful of the immortality of the ſoul, the Stoics could have no idea of the doctrine of election and reprobation; nor did they ever doubt their own freedom of will, or power of doing good as well as evil, as we ſhall preſently ſee the Chriſtian predeſtinarians have done.

Mahomet introduced into his Koran the doctrine of an abſolute predeſtination of the courſe of human affairs. He repreſented life and death, proſperity and adverſity, and every event that befals a man in this world, as the reſult of a previous determination of the one God who rules over all; and he found this opinion the beſt engine for inſpiring his followers with that contempt of danger which, united to their zeal, has extended the empire of their faith over the faireſt portion of the habitable globe.

Predeſtination.

3 When firſt agitated in the church.

The controverſy concerning predeſtination firſt made its appearance in the Chriſtian church about the beginning of the fifth century†. Pelagius a Britiſh, and Cœleſtius an Iriſh, monk, both lived at Rome during that period, and poſſeſſed great celebrity on account of their piety and learning. They taught that the opinion is falſe, which aſſerts, that human nature is neceſſarily corrupted by a depravity derived from our firſt parents.—They contended, that men are born at preſent in a ſtate as pure as that in which Adam was originally created; and that they are not leſs qualified than he was for fulfilling all righteouſneſs, and for reaching the moſt ſublime eminence of piety and virtue: that the external grace of God, which is given unto all, and attends the preaching of the goſpel, is neceſſary to call forth the attention and exertions of men; but that we do not want the aſſiſtance of any internal grace to purify the heart, and to give it the firſt impulſe towards what is good. Having fled into Africa on account of the Goths, who at that time invaded Italy, A. D. 410, Cœleſtius remained at Carthage as a Preſbyter; but Pelagius went into the Eaſt, where he ſettled, and proſpered under the patronage of John biſhop of Jeruſalem, to whom his ſentiments were agreeable. On the contrary, the celebrated Auguſtine, biſhop of Hippo, ſtrenuouſly aſſerted the depravity of human nature ſince the fall of the firſt man, the neceſſity of a ſpecial interpoſition of divine grace to enable us to do any one good action; and conſequently, that none could obtain ſalvation excepting thoſe whom God has thought fit to elect, and upon whom he beſtows this grace. The diſpute was carried on with great zeal. Zozimus biſhop of Rome decided at firſt in favour of Pelagius and Cœleſtius, whoſe followers were called *Pelagians*; but he afterwards altered his opinion: and by the activity of Auguſtine, the council of Epheſus was called, at which the opinion of his antagoniſts was formally condemned.

† *Moſheim. Inſtit. Hiſt. Eccl.*

4 Auguſtine a predeſtinarian.

In the courſe of the ſame century, theſe opinions aſſumed a variety of forms and modifications. One party, called *Predeſtinarians*, carried Auguſtine's doctrine fully farther than he himſelf had ventured to do in expreſs words; and aſſerted, that God had not only predeſtinated the wicked to *puniſhment*, but alſo that he had decreed that they ſhould commit thoſe very *ſins* on account of which they are hereafter to be puniſhed.—Another party moderated the doctrine of Pelagius, and were called *Semipelagians*. Their peculiar opinion is expreſſed in a different manner by different writers; but all the accounts ſufficiently agree. Thus, ſome repreſent them as maintaining that inward grace is not neceſſary to the firſt beginning of repentance, but only to our progreſs in virtue. Others ſay, that they acknowledged the power of grace, but ſaid that faith depends upon ourſelves, and good works upon God; and it is agreed upon all hands, that theſe Semipelagians held that predeſtination is made upon the foreſight of good works. The aſſiſtance of Auguſtine, though then far advanced in life, was called in to combat theſe tenets, and he wrote ſeveral treatiſes upon the ſubject. In all theſe he ſtrenuouſly maintained, that the predeſtination of the elect was independent of any foreſight of

of their good works, but was according to the good pleasure of God only; and that perseverance comes from God, and not from man. Thereafter the doctrine of Augustine, or St Austin as he is often called, became general. He was the oracle of the schoolmen. They never ventured to differ from him in sentiment; they only pretended to dispute about the true sense of his writings.

5
And all the earliest reformers, but more especially Calvin.

The whole of the earliest reformers maintained these opinions of Augustine. They assumed under Luther a more regular and systematic form than they had ever formerly exhibited. But as the Lutherans afterwards abandoned them, they are now known by the name of *Calvinistic Doctrines*, from John Calvin of Geneva. He asserted, that the everlasting condition of mankind in a future world was determined from all eternity by the unchangeable decree of the Deity, arising from his sole good pleasure or free will. Being a man of great ability, industry, and eloquence, Geneva, where he taught, and which was a free state, soon became the resort of all the men of letters belonging to the reformed churches, and was a kind of seminary from which missionaries issued to propagate the Protestant doctrines through Europe. Their success was such, that, excepting a part of Germany, the principles of all the reformed churches are professedly Calviniltic or Predestinarian.

6
Rise of the Arminians.

The opponents of the doctrine of predestination among the Protestants usually receive the appellation of *Arminians* or *Remonstrants*. They derive the first of these appellations from James Arminius, who was, A. D. 1602, appointed * professor of theology at Leyden. He was violently opposed by Gomer his colleague, and died A. D. 1609. After his death, the controversy was conducted with great eagerness on both sides. The Calvinists, however, gradually prevailed. A synod was called at Dort, A. D. 1618, to which the most celebrated divines of different countries were invited. There, in a great measure by the authority and influence of Maurice prince of Orange, the Arminians were condemned as heretics; for by this time ambitious and powerful men found themselves politically interested in this religious contest. The Arminians presented to this synod a remonstrance, containing a statement of their faith upon the subjects in dispute; and from this they derived the appellation of *Remonstrants*. This statement contained the following five articles: 1. That God from all eternity predestinated those to everlasting salvation whom he foresaw would believe in Christ unto the end of their lives; and predestinated obstinate unbelievers to everlasting punishment. 2. Jesus Christ died for the whole human race, and for every individual of it, but believers alone reap the benefit of his death. 3. No man can produce faith in his mind by his own free will, but it is necessary that man, who is by nature wicked and unfit for acting or thinking aright, should be regenerated by the grace of the Holy Spirit, imparted by God for Christ's sake. 4. This divine grace constitutes the source, the progress, and the fulfilment, of all that is good in man; but it is not irresistible in its operation. 5. Believers, by the assistance of the Holy Spirit, are abundantly fitted for every good work; but whether it is possible for those who have once been truly such to fall away, and to perish finally, is not clear, and must be better inquired into by searching the sacred scriptures.

* *Relatio Historica de Origine et Progressu Controversiarum in Phæderato Belgio de Prædestinatione Philippi a Limborch.*

In opposition to these, a counter-remonstrance was presented, containing the opinions of the Calvinists, which was approved of by the synod. The substance of it was afterwards adopted, and in nearly the same expressions, into the Confession of Faith compiled by the assembly of divines which met at Westminster, A. D. 1643, and which every clergyman and probationer for the ministry in Scotland is at present required to subscribe previous to his admission. To give as clear and as fair an idea as possible of the Calvinistic doctrine upon this head, we transcribe the following passage from that Confession: "God from all eternity did, by the most wise and holy counsel of his own will, freely and unchangeably ordain whatsoever comes to pass; yet so, as thereby neither is God the author of sin, nor is violence offered to the will of the creatures, nor is the liberty or contingency of second causes taken away, but rather established. Although God knows whatsoever may or can come to pass upon all supposed conditions; yet hath he not decreed any thing because he foresaw it as future, or that which would come to pass upon such conditions. By the decree of God, for the manifestation of his glory, some men and angels are predestinated unto everlasting life, and others are fore-ordained to everlasting death. These angels and men, thus predestinated and fore-ordained, are particularly and unchangeably designed; and their number is so certain and definite, that it cannot be either increased or diminished. Those of mankind that are predestinated unto life, God, before the foundaton of the world was laid, according to his eternal and immutable purpose, and the secret counsel and good pleasure of his will, hath chosen, in Christ, unto everlasting glory, out of his mere free grace and love, without any foresight of faith, or good works, or perseverance in either of them, or any other thing in the creature, as conditions or causes moving him thereunto; and all to the praise of his glorious grace. As God hath appointed the elect unto glory, so hath he, by the eternal and most free purpose of his will, fore-ordained all the means thereunto. Wherefore, they who are elected, being fallen in Adam, are redeemed by Christ, are effectually called unto faith in Christ, by his spirit working in due season; are justified, adopted, sanctified, and kept, by his power through faith unto salvation. Neither are any other redeemed by Christ effectually called, justified, adopted, sanctified, and saved, but the elect only. The rest of mankind, God was pleased, according to the unsearchable counsel of his own will, whereby he extendeth or with-holdeth mercy as he pleaseth for the glory of his sovereign power over his creatures, to pass by, and to ordain them to dishonour and wrath for their sin, to the praise of his glorious justice."

7
Calvinist doctrine of predestination.

8
Supralapsarians and Sublapsarians.

There are two kinds of Calvinists or Predestinarians, viz. the *Supralapsarians*, who maintain that God did originally and expresly decree the fall of Adam, as a foundation for the display of his justice and mercy; while those who maintain that God only *permitted* the fall of Adam, are called *Sublapsarians*, their system of decrees concerning election and reprobation being, as it were, subsequent to that event. But, as Dr Priestley justly remarks, if we admit the divine prescience, there is

Predestination.

is not, in fact, any difference between the two schemes; and accordingly that distinction is now seldom mentioned.

9
Disputes in the church of Rome on that subject.

Nor was the church of Rome less agitated by the contest about predestination than the first Protestants were. The council of Trent was much perplexed how to settle the matter without giving offence to the Dominicans, who were much attached to the doctrine of Augustine, and possessed great influence in the council. After much dispute, the great object came to be, how to contrive such a decree as might give offence to nobody, although it should decide nothing. Upon the whole, however, they seem to have favoured the Semipelagian scheme. Among other things, it was determined, that good works are of themselves meritorious to eternal life; but it is added, by way of softening, that it is through the goodness of God that he makes his own gifts to be merits in us. Catarin revived at that council an opinion of some of the schoolmen, that God chose a small number of persons, such as the blessed virgin, the apostles, &c. whom he was determined to save without any foresight of their good works; and that he also wills that all the rest should be saved, providing for them all necessary means, but they are at liberty to use them or not. This is called the *Baxterian* scheme in England, from one of its promoters there. But at all events, the council of Trent seems to have been extremely anxious that any opinions entertained among them concerning predestination might have as little influence as possible upon practical morality. "Let no man (say they), while he remains in this mortal state, presume that he is among the number of the elect, and that therefore he cannot sin, or sin without repentance; for it cannot be known who are elected without a special revelation from God." Sess. 6. c. 13.

The Jesuits at first followed the opinion of Augustine; but they afterwards forsook it. *Molina*, one of their order, was the author of what is called the *middle scheme*, or the doctrine of *a grace sufficient for all men*, but subject to the freedom of the human will. *Jansenius*, a doctor of Louvain, opposed the Jesuits with great vigour, and supported the doctrine of Augustine. He wrote in a very artful manner. He declared, that he did not presume to state his own sentiments upon the subject; he pretended only to explain and publish the sentiments of that great father of the church St Augustine. But the Jesuits, in consequence of that inviolable submission to the authority of the pope which they always maintained, had sufficient interest at Rome to procure the opinions of Jansenius to be condemned there; but with this addition subjoined, that nothing was thereby intended to be done in prejudice of the doctrine of St Augustine. This produced an absurd dispute about the pope's infallibility in matters of fact. The Jansenists affirmed, that the Pope had made a mistake in condemning the opinions of Jansenius as different from those of Augustine; whereas in truth they are the same, and the one cannot be condemned without the other. But the Jesuits affirmed, that the pope is no less infallible in points of fact than he is in questions of faith; and he having decided, that the opinions of Jansenius are different from those of St Augustine, every good Catholic is bound to believe accordingly that they are different. These disputes have never been fully settled, and still divide the Roman Catholic churches. Some of the ablest supporters of predestination have appeared among the Jansenists, and particularly among the gentlemen of Port-Royal.

10
English and Scotch reformers predestinarians.

With regard to Great Britain, the earliest English reformers were in general Sublapsarians, although some of them were Supralapsarians. But the rigid Predestinarians have been gradually declining in number in that church, although they still subscribe the 39 articles of their faith, which are unquestionably Calvinistic. The celebrated Scotch reformer John Knox having been educated at Geneva, established in this country the doctrine of predestination in its strictest form: and it has probably been adhered to with more closeness in Scotland than in any country in Europe.

Of late years, however, the dispute concerning predestination has assumed a form considerably different from that which it formerly possessed. Instead of being considered as a point to be determined almost entirely by the sacred scriptures, in the hands of a number of able writers, it has in a great measure resolved itself into a question of natural religion, under the head of the philosophical liberty or necessity of the will (A); or, whether all human actions are or are not necessarily determined

(A) Dr Priestley, the most celebrated Necessarian of the age, has written a whole section of his *Illustrations*, with a view to show, that between "the two schemes of Calvinistic predestination and philosophical necessity, there is no sort of resemblance, except that the future happiness or misery of all men is certainly foreknown and appointed by God. In all other respects (says he) they are most essentially different; and even where they agree in the *end*, the difference in the *manner* by which that end is accomplished is so very great, that the *influence* of the two systems on the minds of those that adopt and act upon them is the reverse of one another." The Calvinistic doctrine of predestination, according to a very authentic statement of that doctrine*, is, that "God, for his own glory, hath *fore ordained whatsoever comes to pass*." The scheme of philosophical necessity, as stated by an intimate friend and warm admirer of Dr Priestley's, is, "That *every thing* is *predetermined* by the Divine Being; that whatever has been, must have been; and that whatever will be, must be; that *all events* are *pre-ordained* by infinite wisdom and unlimited goodness; that the will, in all its determinations, is governed by the state of mind; that this state of mind is in every instance determined by the Deity; and that there is a continued chain of causes and effects, of motives and actions, inseparably connected, and originating from the condition in which we are brought into existence by the Author of our being." The *author* or *compiler* of the same book affirms, "That all motion indeed originates in the Deity; that the Deity is self-moved; that he possesses the singular attribute underived of moving himself." But it is added in the very same paragraph from which this last sentence is quoted, that "the very argument we employ to prove one underived source of motion and

* *Shorter Catechism of the Assembly of Divines at Westminster.*

Predestination.

termined by motives arising from the character which God has impressed on our minds, and the train of circumstances amidst which his providence has placed us? We have already discussed this point (see METAPHYSICS) by giving a candid statement of the arguments on both sides of the question. We shall treat the subject of predestination in the same manner, avoiding as far as possible any recapitulation of what has been advanced under the head of *Necessity and Liberty*.

11
Points at issue between the predestinarians and their opponents.

From what has been already said, it will appear that the points chiefly at issue between the parties are the following: First, With what views and purposes did God create the world and frame his decrees concerning mankind? Did he contrive a great unalterable scheme of creation and providence only for the sake of manifesting his own glory and perfections? Or did he first consider the free motions of those rational agents whom he intended to create, and frame his decrees upon the consideration of what they might choose or do in all the various circumstances in which he intended to place them?—The second and following questions are branches of this leading one. Did Christ die for a particular portion of the human race, who shall therefore certainly be saved? or was his death intended as a benefit to all, from which none are excluded excepting those who willingly reject it? Is the divine grace certainly and irresistibly efficacious in all those minds to which it is given? or does its effect depend upon the good use which men may or may not make of it? Can any good action be done without it? Do those who have once received it certainly persevere and obtain eternal salvation? or is it possible for any of them to fall away and perish finally?

12
Arguments for the doctrine

* Calvini Respons. contra Pigbaium, ad 2um lib.

WE shall begin by stating the argument on the side of the predestinarians, and in the language which they commonly use. But it is necessary to make this previous remark, that the general* objections to their doctrine are, that it is hostile to all our ideas of the justice of God, representing him as a partial being, rewarding without merit, and punishing without sin; that it renders him the author of evil, destroys moral distinctions, makes useless every effort on our part, makes every prayer absurd, and even the preaching of the gospel vain; seeing that all things are immutably fixed, and none can believe or be saved excepting the elect, and they must certainly and at all events be safe. Against all this they reason thus.

The great and everlasting Author of all things existed from eternity alone, independent and essentially perfect. As there was no other, he could only consider himself and his own glory. He must therefore have designed all things in and for himself. To make him stay his determinations till he should see what free creatures would do, is to make him decree with uncertainty, and dependently upon them, which falls short of infinite perfection. He existed alone, and his councils could have no object excepting himself; he could only then consider the display of his own attributes and perfection. In doing this, as the end is more important than the means, Divine Wisdom must begin its designs with that which is to come last in the execution of them; but the conclusion of all things at the last judgement will be the complete manifestation of the wisdom, the goodness, and justice, of God: we must therefore suppose, that, in the order of things, he decreed that first, although with him, in the order of time, there is no first nor second, but all is from eternity. When this great design was laid, the means were next designed. Creation, and its inhabitants of every order, form the means by which the author and disposer of all things accomplishes his will. But creatures in his sight are nothing, and are figuratively said to be less than nothing. We may entertain proud and elevated conceptions of our own dignity if we please; but if we in our designs regard not the dust on which we tread, or the lives of ants and insects, the omnipotent Lord of all, from whom we are more infinitely distant, must regard us as at least equally inconsiderable, and only valuable as we serve the acccomplishment of his great and mysterious purposes, which cannot be us or our aggrandisement, but himself and his own glory.

13
As necessary to explain the Divine attributes.

It is only by this view of the divine conduct that some of the attributes of God can be explained, or their existence rendered possible. In the scriptures he claims the attribute of *prescience* as his distinguishing prerogative: but there can be no prescience of future contingencies; for it involves a contradiction to say, that things which are not certainly to be should be certainly foreseen. If they are certainly foreseen, they *must* certainly be, and can therefore be no longer contingent. An uncertain foresight is also an imperfect act, as it may be a mistake, and is therefore inconsistent with divine perfection. On the other side the difficulty is easily explained. When God decrees that an event shall take place, its existence becomes thenceforth certain, and as such is certainly foreseen. For it is an obvious absurdity to say, that a thing happens freely, that is to say, that it may be or may not be, and yet that it is certainly foreseen by God. He cannot foresee things but as he decrees them, and consequently gives them a future certainty of existence; and therefore any prescience antecedent to his decree must be rejected as impossible. Conditional decrees are farther absurd, inasmuch as they subject the purposes of God to the will and the actions of his creatures. Does he will, or wish that all mankind should be saved, and shall they not all be saved? Infinite perfection can wish nothing but what it can execute; and if it is fit to wish, it is also fit to execute its wishes. We are indeed certainly informed by the scrip-

8

---

and existence, is a gross solecism in logic; and that the ascription of this power to the Divine Being is in fact nothing else than the less of two palpable *absurdities* or rather *impossibilities*, if these could admit of degrees.†"

The piety of these assertions will be obvious, we are persuaded, to every one of our readers; but to some it is possible that their consistency may not be apparent. We would advise all such "to peruse once and again Dr Priestley's Illustrations," which, we have the best authority to say, will remove from their minds all libertarian prejudices, convince them "that the hypothesis of necessity is incontrovertibly true," and show them that all the defenders of that hypothesis are in perfect harmony with themselves and with one another!

† *Essay Philosoph. Necessity Alexander Crombie, A. M.*

eſtina-ion.

ſcriptures, that all ſhall not be ſaved; and we therefore as certainly conclude, that God never intended that they ſhould be ſo; *for the counſel of the Lord ſtandeth faſt, and the thoughts of his heart, to all generations.*

14 ſt died for elect.

We conclude upon the ſame principles, that although the bleſſings reſulting from the death of Chriſt are offered to all, yet that intentionally and actually he only died for thoſe whom the Father had choſen and given to him to be ſaved by him. That Chriſt ſhould have *died in vain* is repreſented by the apoſtle Paul as a great abſurdity (Gal. ii. 21.): but if he died for all, he muſt have died in vain with regard to the greater part of mankind who are not to be ſaved by him. In ſo far as ſome inferior bleſſings are concerned, which through him are communicated, if not to all men, at leaſt to all Chriſtians, he may perhaps juſtly be ſaid to have died for all: but with regard to eternal ſalvation, his deſign, to avoid rendering it fruitleſs, could go no farther than the ſecret purpoſe and election of God. This is implied in theſe words, *all that are given me of my Father, thine they were, and thou gaveſt them me.* To theſe his interceſſion is limited; *I pray not for the world, but for thoſe that thou haſt given me; for they are thine, and all thine are mine, and mine are thine* (Jo. xvii. 9, 10.) Univerſal words are indeed uſed with regard to the death of Chriſt: but the reaſon is obvious, the Jewiſh religion was confined to the family and deſcendants of Abraham. In contradiction to this, the goſpel is ſaid to be preached to *every creature*, and *to all the world;* becauſe it is not limited to any one race or nation, and becauſe the apoſtles received a general commiſſion to teach it unto all who ſhould be willing to receive it. Theſe extenſive expreſſions can only be underſtood in this manner, becauſe in their ſtrict acceptation they have never been verified. Nor can their meaning be carried farther without an imputation upon the juſtice of God: for if he has received a ſufficient ſatiſfaction for the ſins of the whole world, it is not juſt that all ſhould not be ſaved by it, or at leaſt have the offer of ſalvation made to them, that they may accept of it if they pleaſe.

But to return to the divine purpoſes and attributes in general: it is in vain to aſſert that God is partial and unjuſt while he prefers without merit, and predeſtinates to puniſhment thoſe who have not yet offended. The ſame error miſleads men here that has ſo often ſeduced them from the true path of ſcientific reſearch. Inſtead of ſubmitting to the patient and humble obſervation of nature, they boldly form ſome plauſible hypotheſis of their own, and vainly attempt to reconcile every appearance to their favourite ſyſtem. This mode of procedure never has proved, and never will prove, ſucceſsful in any branch of true philoſophy. We are not entitled to frame to ourſelves certain notions of the juſtice of God, and from theſe to decide that thus he muſt act and in no other manner. He takes no counſel from us concerning his conduct, and we have no right to rejudge his judgments. What he regards as juſt or unjuſt between himſelf and his creatures, is a queſtion of fact not to be known by ingenious conjectures, but by the cautious obſervations of the manner in which he acts in the courſe of his providence, and by attending to what he has declared concerning himſelf in the ſacred ſcriptures. If from theſe it ſhall appear that he does prefer where there is no merit, and reject where there is no crime; it will be in vain thereafter to aſſert that ſuch conduct is unjuſt: the fact will be on our ſide of the queſtion, and we ſhall leave thoſe to account for it who inſiſt that their limited reaſon is capable of comprehending all the myſterious ways of an Infinite Being.

Predeſtination.

15 Great inequalities in the ordinary courſe of providence.

In the courſe of providence, then, we ſee the greateſt inequalities take place, and ſuch as appear altogether contradictory to our ideas of juſtice. We ſee the ſins of the fathers puniſhed in the perſons of the children, who often derive debilitated bodies from the intemperance of their parents, and corrupted manners from the example of their vices. God frequently afflicts good men in this life for a great length of time, as in the caſe of Job, only for the manifeſtation of his own glory, that their faith and patience may be made manifeſt. Some ſins are puniſhed with other ſins, and often with a courſe of ſevere miſeries in the perſons of thoſe who never committed them. We may transfer this from time to eternity; for if God may do for a little time what is inconſiſtent with our notions, and with our rules of juſtice, he may do it for a longer duration: ſince it is as impoſſible that he can be unjuſt for a day as for all eternity: and the ſame inequality of management appears in the great as in the private affairs of this world. During many ages almoſt the whole human race were loſt in the darkneſs of idolatry: even ſince the Chriſtian religion came into the world, how few nations have received it; and of theſe few, the number is ſtill ſmaller of thoſe who have enjoyed it in tolerable purity. If we conſider how many great nations remain under the deluſion contrived by Mahomet; if we reflect upon the idolatry of the Indies and of China, and the ſuperſtition of the Greek church, and of the church of Rome—we ſhall find that very few nations have poſſeſſed the moſt ordinary means of grace. Even the bleſſings of civilization, of ſcience, and of liberty, are ſo rarely ſcattered over the face of the earth, that it is to be regarded as a melancholy truth, that with a very few favoured exceptions the whole human race have hitherto been ſunk in the depth of barbariſm, ignorance, ſlavery, and idolatry. When the Arminians think fit to aſſert, then, that the doctrine of abſolute decrees is contrary to their ideas of the impartiality and juſtice of God, we can only anſwer that we are ſorry for them if they have formed ideas of the character of God which are contrary to the truth. We preſume not * like them to call his attributes before the tribunal of our underſtandings; we only obſerve the ways of his providence, and declare that thus ſtands the fact. If he leaves whole nations in darkneſs and corruption, and freely chooſes others to communicate the knowledge of himſelf to them, we need not be ſurpriſed if he act in the ſame manner with individuals. For ſurely the rejecting immenſe empires for ſo many ages is much more unaccountable than the ſelection of a few individuals, and the leaving others in ignorance and depravity. It is in vain to allege that he extends his mercy to thoſe who make the beſt uſe of the dim light which they have. This does not remove the difficulty of a choice and a preference; as it cannot be denied that their condition is very deplorable, and that the condition of others is much more hopeful: ſo that the myſterious doctrine of election and reprobation is an unqueſtionable truth under the government of God, ſeeing that great numbers of men are born in ſuch circumſtances that it is morally impoſſible they ſhould not pe-

* *Calvini Tract. de Æterna Dei Prædeſt.*

Predeſtination.

riſh in them; whereas others are more happily ſituated and enlightened.

16 The language of Scripture predeſtinarian.

Nor are we left to common obſervation upon this point. The language of the ſacred ſcriptures is poſitive and clear. The whole reaſoning in the ninth chapter to the Romans reſolves all the acts of God's juſtice and mercy, his *hardening* as well as his *pardoning*, into an abſolute freedom and an unſearchable depth. More pointed expreſſions for this purpoſe can ſcarcely be conceived than thoſe actually made uſe of. *For the children being not yet born, neither having done any good or evil, that the purpoſe of God according to election might ſtand, not of works, but of him that calleth, it was ſaid, The elder ſhall ſerve the younger. As it is written, Jacob have I loved, but Eſau have I hated. What ſhall we ſay then? Is there unrighteouſneſs with God? God forbid. For he ſaith to Moſes, I will have mercy on whom I will have mercy, and I will have compaſſion on whom I will have compaſſion. So then it is not of him that willeth, nor of him that runneth, but of God that ſhoweth mercy; for the ſcripture ſaith unto Pharaoh, Even for this ſame purpoſe have I raiſed thee up, that I might ſhow my power in thee, and that my name might be declared throughout all the earth. Therefore hath he mercy on whom he will have mercy, and whom he will he hardeneth.*

17 An objection anſwered.

If any man ſhall ſtill be ſufficiently bold to declare that all this is contrary to what he is pleaſed to conſider as juſt and impartial, we can only reply to him in the words of the celebrated John Calvin of Geneva †. *Tibi moleſtum eſt ac odioſum, Deum plus poſſe et facere, quam mens tua capiat; æquali autem tuo interdum concedes, ut ſuo judicio fruatur. Et tu in tanto furore, Dei mentionem ullam facere audes?* "Is it painful to thee that the power and the works of God exceed thy limited capacity? Thou ſometimes ſuffereſt thine equal to judge of his own conduct for himſelf, and dareſt thou in thy folly to cenſure the ways of God?" Or rather we may reply in thoſe words of the apoſtle Paul which immediately follow the paſſage already quoted. *Thou wilt ſay then to me, Why doth he yet find fault? for who hath reſiſted his will? Nay but, O man, who art thou that replieſt againſt God? Shall the thing formed ſay to him that formed it, Why haſt thou made me thus? Hath not the potter power over the clay; of the ſame lump to make one veſſel unto honour, and another unto diſhonour?* Let theſe paſſages, and even the whole of the chapter now alluded to, be explained in any manner that is judged proper, ſtill their import with regard to the preſent argument will remain the ſame. If God loved Jacob ſo as to chuſe his poſterity to be his people, and rejected or hated Eſau and his poſterity, and this without regard to them or their future conduct, but merely in conſequence of the purpoſe and deſign of his election; if by the ſame purpoſe the Gentiles were to be grafted upon that ſtock from which the once favoured Jews were cut off; it will follow, not only that the great and myſterious decree of final election is unſearchably free and abſolute, but alſo that all the means of grace are granted or withheld in the ſame unlimited and free manner according to the ſovereign will and good pleaſure of God, independent of any foreſight of merit on our part. The words of our Saviour expreſs this: *I thank thee O Father, Lord of heaven and earth, becauſe thou haſt hid theſe things from the wiſe and prudent, and haſt revealed them unto babes:* The reaſon of which is given in the following words, *Even ſo, Father, for ſo it ſeemed good in thy ſight*, (Mat. xi. 26). The paſſage immediately preceding this, ſhows clearly that the means of grace are not beſtowed upon thoſe who, it is foreſeen, will make a good uſe of them; nor denied to thoſe who will make a bad uſe of them. *Wo unto thee Chorazin, wo unto thee Bethſaida: for if the mighty works which were done in you had been done in Tyre and Sidon, they would have repented long ago in ſackcloth and aſhes.* But the paſſages in ſcripture are innumerable, which declare that the whole character and deſtiny of every man is the reſult of the counſel and uncontrouled determination of God. The expreſſion is often repeated in the book of Exodus; God *hardened the heart of Pharaoh, ſo that he would not let his people go*, (Exod. iv. 21), &c. It is ſaid, that *God has made the wicked man for the day of evil*, (Prov. xvi. 4). On the other hand, it is ſaid, *as many believed the goſpel as were appointed to eternal life*, (Acts i. 48.) Some are ſaid to be *written in the book of life, of the Lamb ſlain from the foundation of the world* (Rev. xiii 8.) Every prayer that is uſed, or directed to be uſed, in ſcripture, is for a grace that opens our eyes, that turns the heart, that makes us to go, that leads us not into temptation, but delivers us from evil. All theſe expreſſions denote that we deſire more than a power or capacity to act, ſuch as is given to all men. Indeed we do not, and we cannot, pray earneſtly for that which we know all men as well as ourſelves poſſeſs at all times.

† *Ubi ſupra.*

18 Sure efficacy of grace.

The *grace of God* is the medium by which his ſovereign will and abſolute decrees are accompliſhed. Accordingly, it is ſet forth in ſcripture by ſuch expreſſions as clearly denote its ſure efficacy; and that it does not depend upon us to uſe it or not at our pleaſure. It is ſaid to be a creation; *we are created unto good works, and we become new creatures:* It is called a regeneration, or a *new birth;* it is called a quickening and a reſurrection, as our former ſtate is compared to a feebleneſs, a blindneſs, and a death. God is ſaid *to work in us both to will and to do: His people ſhall be willing in the day of his power: He will write his laws in their hearts, and make them to walk in them.* In a paſſage already quoted, the human race are compared to a maſs of *clay* in the hands of the *potter*, who of the ſame lump makes at his pleaſure *veſſels of honour and diſhonour.* Theſe paſſages, and this laſt more particularly, prove that there is an abſolute and a conquering power in divine grace; and that the love of God conſtrains us, as St Paul expreſſes himſelf. Our Saviour compares the union and influence that he communicates to believers to the union of an head with the members, and of a root with the branches, which imparts an internal, a vital, and an efficacious influence. The outward means may indeed be rejected, but this overcoming grace never returns empty: theſe outward means coming from God, the reſiſting of them is ſaid to be the *reſiſting* of God, the *grieving* or *quenching of his ſpirit;* and in that ſenſe we may reſiſt the grace or favour of God; but we can never withſtand him when he intends to overcome us; *For the foundation of God ſtandeth ſure, having this ſeal, The Lord knoweth them that are his*, (2 Tim. ii. 19.) *Having predeſtinated us unto the adoption of children by Jeſus Chriſt himſelf, according to the good pleaſure of his will*, (Eph. i. 5.)

19 Perſeverance of the ſaints.

That the ſaints ſhall certainly perſevere unto the end is a neceſſary conſequence of abſolute decrees and of efficacious grace: all depends on God. He *of his own will begat us;* and with him *there is no variableneſs nor ſhadow of turning: whom he loves, he loves to the end:* and he has promiſed that he will never leave nor forſake thoſe to whom he becomes a God. Our Lord hath

hath said, *I give unto them eternal life, and they shall never perish; neither shall any pluck them out of my hand*, (Jo. x. 28.) Hence we must conclude, that *the purpose and calling of God is without repentance*, (Heb. xiii. 5.) And therefore, although good men may fall into great sins, yet of all those who are given by the Father to the Son to be saved by him, none are lost: The conclusion from the whole is, that God did in himself, and for his own glory, *foreknow* a determinate number in whom he would be both sanctified and glorified.* These he *predestinated* to be holy, conformable to the image of his son: they are to be *called*, not by a general calling in the sense of these words, *many are called, but few are chosen*; but to be *called according to his purpose*. He *justified* them upon their obeying that calling, and in the conclusion he will *glorify* them; for nothing can separate us from the love of God in Christ, (Rom. ix. 19.) And he is not less absolute in his decree of reprobation than he is in his election: for *ungodly men* are said to be *of old ordained to condemnation, and to be given up by God unto vile affections, and to be given over by him to a reprobate mind.*

20 Arguments against the doctrine from the attributes of God.

THUS far we have defended the doctrine of predestination: we proceed next to state the arguments usually adduced in favour of the Arminian system.

God is just, holy, and merciful. In speaking of himself in scripture, he is pleased to make appeals to the human understanding, and to call upon men to reason with him concerning his ways. The meaning of this is, that men may examine his actions and his attributes with that measure of intelligence which they possess, and they will be forced to approve of them; nay, he proposes himself to us as a pattern for our imitation. We are required to be holy as he is holy, and merciful as he is merciful: which is a proof that he accounts us not incapable of forming just notions at least of these attributes. What then can we think of a justice that shall condemn us for a fact that we never committed? that designs first of all to be glorified by our being eternally miserable, and which afterwards decrees that we shall commit sins to justify this previous decree of our reprobation? For if God originally designs and determines all things, and if all his decrees are certainly effected, it is inconceivable how there should be a justice in punishing that which he himself, by an antecedent and irreversible decree, appointed to be done. Or, setting justice aside, is it possible that a being of infinite holiness, and who is *of purer eyes than to behold iniquity*, would by an antecedent decree fix our committing so many sins, in such a manner that it is not possible to avoid them? He represents himself in the scriptures as *gracious, merciful, slow to anger, and abundant in goodness and truth.* It is often said, that *he desires that no man should perish, but that all should come to the knowledge of the truth:* this is even said with the solemnity of an oath, *As I live, saith the Lord, I take no pleasure in the death of sinners.* What sense can these words bear if we believe that God did by an absolute decree doom so many of them to everlasting misery? If all things that happen arise out of the absolute decree of God as their first cause, then we must believe that God takes pleasure both in his own decrees and in the execution of them, consequently that *he doth take pleasure in the death of sinners*; and this in express contradiction to the most positive language of scripture. Besides all this, what are we to think of the truth of God, and of the sincerity of those offers of grace and mercy, with the exhortations and expostulations upon them that occur so frequently in scripture, if we can imagine that by antecedent acts he determined that all these should be ineffectual? In one word, are we to regard our existence as a blessing, and to look up with gratitude to that paternal goodness which has placed us in a *land* of hope, which formed our nature, weak indeed and exposed to many imperfections, but capable of rising by virtuous efforts and by a patient continuance in well-doing to excellence and to high and immortal felicity? or, are we to curse the hour in which we were born under the dominion of a master, who is not only severe, but absurd, and even adds insult to cruelty; who, after placing us in a goodly habitation, binds us hand and foot, locks the door, blocks up the windows, sets fire to the fabric, and then very mercifully calls upon us to come forth lest we perish?

It is not true that rational beings are nothing in the sight of their Maker. Compared to his Almighty strength and uncreated existence, our powers do indeed diminish into weakness, and our years into a moment: yet although our interests may be unimportant in themselves, the attributes of God with which they are connected are far from being so. There was no necessity for his calling us into existence; but the instant he bestowed upon us that gift, and conferred upon us faculties capable of rising to happiness by the contemplation of himself and of his works, he became our parent, and granted to us a right to look up to him for protection and mercy, and to hope that our existence and our faculties were not bestowed in vain. Nor will he trample upon the just and reasonable hopes of the meanest of his creatures. He is watchful over our interests; he hath sent his Son to die for us; his providence has been exerted for no other purpose but to promote our welfare; and there is joy in heaven even over one sinner that repenteth. Let it be allowed, that the universe was formed for no other purpose but to promote the glory of God; that glory can surely be little promoted by the exertion of undistinguishing and blind acts of power, in the arbitrary appointment to eternal reprobation of millions of unresisting and undeserving wretches *. Is it not more honourable to the Deity to conceive of him as the parent, guide, governor, and judge of free beings, formed after the likeness of himself, with powers of reason and self-determination, than to conceive of him, as the former and conductor of a system of conscious machinery, or the mover and controuler of an universe of puppets, many of whom he is pleased to make completely miserable? The most important and fundamental point of religion, considered as a speculative science, consists in our forming high and just ideas of God and of his attributes, that from them we may understand the maxims of true and perfect morality. But were we to attempt to form our own natures upon the idea of the divine character that is given us by the doctrine of absolute decrees, we would certainly become imperious, partial, and cruel; at least we should not readily learn the virtues of kindness, mercy, and compassion.

* *Correspondence between Price and Priestley.*

21 The difficulty of prescience solved.

It is true that, setting aside predestination, it is not easy to show how future contingencies should be certainly

Predeſtination. certainly foreſeen; but it is obvious that ſuch foreſight involves no contradiction, (ſee METAPHYSICS, n° 308); and if the actions of men be free, we know from the train of prophecies, which in the ſacred ſcriptures appear to have been made in one age and fulfilled in another, that contingencies are foreſeen by that infinite Being who inhabiteth eternity, and to whom a thouſand years are but as one day. The prophecies concerning the death and ſufferings of Chriſt were fulfilled by the free acts of the Jewiſh prieſts and people: Theſe men ſinned in accompliſhing that event, which proves that they acted with their natural liberty. From theſe and all the other prophecies both in the old and new Teſtament, it muſt be confeſſed that future contingencies were certainly foreknown, but where to found that certainty cannot be eaſily reſolved. We doubt not, however, that we may ſafely refer it to the infinite perfection of the Divine mind. And it ought to be obſerved that this difficulty is of a very different nature from that to which our antagoniſts are reduced on their ſide of the argument. They are compelled to confeſs that they cannot reconcile their doctrine with the juſtice of God, an attribute the nature of which we clearly underſtand, and which is held forth to our imitation; whereas we are only at a loſs how to explain the mode in which the divine preſcience is exerted; an attribute which God claims as peculiarly his own, and which it is not to be expected that we ſhould be able in the ſmalleſt degree to comprehend. We can go farther than this. Heaven hath given to man two revelations of itſelf. The one conſiſts in the knowledge which we procure by the right uſe of our rational faculties; and the other is beſtowed by means of the ſacred ſcriptures. Without intending to derogate from the authority of inſpiration, it is fair to aſſert, that we are *more certain* that God is the author and beſtower of our reaſon, than that he is the author of the ſcriptures; at leaſt it is certain that the laſt cannot contradict the firſt, becauſe God cannot contradict himſelf. By the primary revelation from heaven then, that is, by our reaſon, we are informed that God is true, and juſt, and good. If an angel from heaven ſhould preach a doctrine contrary to this, we are entitled to ſay with the apoſtle, *let him be accurſed*. If our antagoniſts then ſhould ſucceed in proving that the doctrine of abſolute decrees, which repreſents the Deity as cruel and unjuſt, is contained in ſcripture, the conſequence would be, not that we would believe it, for that is impoſſible, but that we ſhould be reduced to the neceſſity of rejecting the authority of the ſcriptures, becauſe they contradict the previous ſure revelation of God, our reaſon. We believe that the doctrines contained in the ſcriptures are certainly true, becauſe they were taught by thoſe who wrought miracles and foretold future events in proof of their being inſpired by the God of truth. But miracles and prophecy are *direct* evidences of nothing but the *power* and *wiſdom* of their Author; and unleſs we know by other evidence, that this powerful and wiſe Being is likewiſe the father of truth and juſtice, we cannot be ſure that the ſcriptures, notwithſtanding their ſource, are any thing better than a tiſſue of falſehoods. The very arguments therefore by which predeſtination is ſupported, tend to ſap the foundation of that revelation from which its advocates pretend to draw them. The caſe is very different when no doctrine is aſſerted that is not contradictory to our reaſon, but only above it. For example, when we are told that God can create rational beings, that he attends without diſtraction to the minuteſt affairs that paſs in a thouſand worlds, that he knows all things, the paſt, the preſent, and the future, we do not preſume that we comprehend how he can do all this: but there is nothing in it that contradicts our reaſon; we ourſelves poſſeſs a certain degree of power, can attend at once to a certain number of objects, can in ſome caſes form very ſure conjectures about futurity, and we reſolve all the reſt into the infinite nature and perfections of God.

22 Scripture cannot contradict the clear dictates of reaſon.

It is farther to be obſerved, that preſcience does not make effects certain becauſe they are foreſeen; but they are foreſeen becauſe they are to be: ſo that the certainty of the preſcience is not the cauſe, but the conſequence of the certainty of the event. The Roman republic has fallen; but our knowledge or ignorance of that event does not render it more or leſs true and certain. That it was to fall, was as ſurely true before it happened as it is now; and had we known it beforehand, as many men of ſenſe probably did, it would neither have fallen ſooner nor later on that account. This ſhows that the knowledge which an intelligent being has of a paſt or future event need not have any influence upon the circumſtances that produce that event.

23 Conditional preſcience.

On ſome occaſions the ſcripture takes notice of a conditional preſcience *. God anſwered David, that Saul would come to Keilah, and that the men of Keilah would deliver him up: yet both the one and the other reſted upon the condition of his ſtaying there; and he going from thence, neither of them ever happened. Such alſo was the † prophecy of Jonah, at the failure of which he was ſo abſurdly offended: and ſuch was Chriſt's ſaying, That thoſe of Tyre and Sidon, Sodom and Gomorrah would have turned to him, if they had ſeen the miracles that he wrought in the towns of Galilee. Since, then, this preſcience may be ſo certain that it can never err nor miſlead the exertions of providence, and ſince by this, both the attributes of God are vindicated, and the due freedom of man is aſſerted, all difficulties ſeem to be thus eaſily removed.

* 1 Sam. xxiii. 11, 12.

† Chap. 4.

24 Chriſt died for the whole world.

With regard to the purpoſe of Chriſt's death, he is ſaid to be the *propitiation for the ſins of the whole world*; and the wicked are ſaid *to deny the Lord that bought them*. His death, as to its extent, is ſet in oppoſition to the ſins of *Adam*; ſo that as by the offence of one judgment came upon all men to condemnation, ſo by the righteouſneſs of one the free gift came upon all men to juſtification of life, (Rom, v. 18.) The *all* on the one ſide muſt be as extenſive as the *all* on the other: ſo, ſince *all* are concerned in Adam's ſin, *all* muſt likewiſe be concerned in the death of Chriſt. To this we may add, that *all* men are commanded and required to believe that Chriſt died for their ſins; but no man can be obliged to believe what is not true: he muſt therefore have died for *all*. The following paſſages expreſs clearly the univerſality of the object of Chriſt's death. *If any man ſin, we have an advocate with the Father, Jeſus Chriſt the righteous: and he is the propitiation for our ſins: and not for ours only, but alſo for the ſins of the whole world*, (1 Jo. ii. 1, 2.) *The love of Chriſt conſtraineth us; becauſe we thus judge, that if one died for all, then were all dead: and that he died for all, that they which live ſhould*

ſtina-
or.

ſhould not henceforth live unto themſelves, (2 Cor. v. 14.) *God ſo loved the world that he gave his only begotten Son, that whoſoever believeth in him might not periſh, but might have everlaſting life.* (Jo. iii. 16.)

5
dom
ial to
l a-

But a proper attention to the nature of man will ſet the juſtice of our argument in a ſtill ſtronger point of view. It is obvious, that ſuch an inward freedom as renders a man the maſter of his own conduct, and able to do or not do what he pleaſes, is ſo neceſſary to the morality of our actions, that without it they are neither good nor evil, neither capable of rewards nor puniſhments. Madmen, or men aſleep, are not to be charged with the good or evil of what they do; therefore at leaſt ſome ſmall degree of liberty muſt be left us, otherwiſe why are we praiſed or blamed for our conduct? All virtue and religion, all diſcipline and induſtry, ariſe out of this as their firſt principle, that there is a power in us to govern our own thoughts and actions, and to raiſe and improve our faculties. If this is denied, all efforts, all education, all attention beſtowed upon ourſelves or others, become fruitleſs and vain. If a man accounts himſelf under an inevitable decree, as he will have little remorſe for the evil he does while he imputes it to that inevitable force that conſtrains him, ſo he will naturally conclude that it is to no purpoſe for him to ſtruggle with impoſſibilities. Men are ſufficiently inclined to throw all cenſure off from themſelves, and to indulge in indolence; and upon the doctrine of abſolute predeſtination who can blame them, ſeeing that their efforts can be of no value?

Matter is inactive of itſelf, and only moves in conſequence of its being acted upon by ſome other being. Man is poſſeſſed of a power to begin motion, and to determine it in any direction that he may judge proper. This power and this intelligence conſtitute his liberty, and form that image of God that is ſtamped upon his

6
rty or
ſity a
eſt on
ct.

nature. Whether man poſſeſſes this power of acting originally and of himſelf, or whether he is incapable of forming any reſolution, or making any effort, without being acted upon by a foreign cauſe, is not a point to be reaſoned on or diſputed about: it is a queſtion of fact, which, as far as it can poſſibly be known, every man has it in his power to determine by the evidence of his own conſciouſneſs. We do aver, then, that every man is conſcious that he is a free agent, and that it is not poſſible for the moſt ſtaunch predeſtinarian that has ever yet appeared ſeriouſly and practically to convince himſelf of the contrary. It is not poſſible for a man in his ſenſes to believe, that in all thoſe crimes which men charge *themſelves* with, and reproach *themſelves* for, God is the agent; and that, properly ſpeaking, they are no more agents than a ſword is when employed to commit murder. We do indeed, on ſome occaſions, feel ourſelves hurried on ſo impetuouſly by violent paſſions, that we ſeem for an inſtant to have loſt our freedom; but on cool reflection we find, that we both might and ought to have reſtrained that heat in its firſt commencement. We feel that we can divert our thoughts, and overcome ourſelves in moſt inſtances, if we ſet ſeriouſly about it. We feel that knowledge, reflection, and proper ſociety, improve the temper and diſpoſition; and that ignorance, negligence, and the ſociety of the worthleſs and abandoned, corrupt and degrade the mind. From all this we conclude, that man is free, and not under inevitable fate, or irreſiſtible motions to good or evil. This concluſion is confirmed by the whole ſtyle of ſcripture, which upon any other ſuppoſition becomes a ſolemn and unworthy mockery. It is full of perſuaſions, exhortations, reproofs, expoſtulations, encouragements, and terrors. But to what purpoſe is it to ſpeak to dead men, to perſuade the blind to ſee, or the lame to run? If we are under impotence till the irreſiſtible grace comes, and if, when it comes, nothing can withſtand it, what occaſion is there for theſe ſolemn diſcourſes which can have no effect? They cannot render us inexcuſable, unleſs it were in our power to be improved by them; and to imagine that God gives light and bleſſings, which can do no good, to thoſe whom he before intended to damn, only to make them more inexcuſable, and for the purpoſe of aggravating their condemnation, gives ſo ſtrange an idea of his character as it is not fit to expreſs in the language that naturally ariſes out of it.

Predeſtination.

27
Some of the acts of God depend on the conduct of his creatures.

Our antagoniſts ſeem to have formed ideas of the divine perfection and ſovereignty that are altogether falſe. There is no imperfection implied in the ſuppoſition that ſome of the acts of God may depend upon the conduct of his creatures. Perfection conſiſts in forming the wiſeſt deſigns, and in executing them by the moſt ſuitable means. The author of nature conducts the planets in their orbits with immutable preciſion according to fixed rules: but it would be abſurd to pretend to manage free agents, or their affairs, in the ſame manner by mathematical or mechanical principles. The providence that is exerted over material objects is fixed and ſteady in its operations, becauſe it is fit that material objects which cannot move of themſelves ſhould be moved in a regular manner: but free and intelligent beings enjoy a wider range, and ought not to be confined to a preſcribed train of exertions; it may therefore be neceſſary that the providence which ſuperintends them ſhould accommodate itſelf to circumſtances. This, however, is not injurious to the divine ſovereignty; for God himſelf is the author of that freedom of agency which he is pleaſed to watch over. He is not leſs the Lord of the univerſe; and ſurely his wiſdom and benevolence are more conſpicuous when he brings good out of evil, and renders the perverſe wanderings of the human heart ſubſervient to purpoſes of mercy, than when he hurls into the immenſity of ſpace the moſt enormous maſs of dead and paſſive matter ſubjected to unerring laws.

28
The inequalities of Providence accounted for.

As for the inequalities of moral ſituation that are to be obſerved in the world, and the giving to ſome nations and perſons the means of improvement, and the denying them to others, the ſcriptures do indeed aſcribe theſe wholly to the riches and freedom of God's grace. And, we confeſs, that the ways of Providence are often dark and myſterious. In this world there are many things which are hard to be underſtood, and many which appear altogether unaccountable; we ſee the wicked man proſpering in his wickedneſs, though it impoſe miſery upon thouſands; we ſee truth hiding its head, and the world governed by fraud and abſurdity. Still, however, we can venture to aſſert, that God beſtows upon all what is neceſſary to enable them to fulfil the obligations expected from the ſtate in which they are placed; and it is elſewhere ſhown, that phyſical evil is among men the parent of moral good. (See Providence). God winketh at the times of ignorance;

Predestination.

much is required of them to whom much is given; and it shall be more tolerable in the day of judgment for the inhabitants of Sodom and Gomorrah than for the enlightened cities of Galilee. Thus God will be just when he judges; none will meet with condemnation excepting those who are inexcusable. For although he grants more to some than may be absolutely necessary, yet he grants less to none; and where he grants little, he will suit his judgments to the little which he gave. There is no injustice in this. If it was the intention of the great Creator that his creation should contain within its ample bosom every possible variety of intelligent natures, it was necessary that there should be somewhere such a being as man; and, in forming all possible varieties of human minds and situations, it was necessary that every particular individual should exist. Hence a man may as well complain that he was not formed one of the flaming seraphims that surround the throne of the Eternal, as that he is not placed in other circumstances in life than those which he now occupies; for if little is given, little will be required from him. Thus the designs of Providence go on according to the goodness and mercy of God. None can complain, though some have more cause for joy than others. What happens to individuals may happen to nations in a body; some may have higher privileges, and be placed in happier circumstances than others; but none can complain of the wise and just disposer of all, who has given enough, although we may have good reason to complain of ourselves, for not using what was sufficient.

As to the case of those who are not blessed with the light of the gospel, we may consider, that if they have fewer and less advantages than others, their nature and capacities must likewise be inferior; to which their future state may be proportioned. God is not obliged to make all men equally perfect in the next world any more than in this; and if their capacity be rendered less than that of an ordinary *Christian*, a lower degree of happiness may fill it. However, we need not be extremely solicitous about their state, much less cast any ungrateful imputations on the Governor of the world for not having dealt so bountifully with them as he has with ourselves; since we know that Christ died for the whole race of mankind; that every one will at length be 'accepted according to that he has, and not according to that he has not; and that to whomsoever much is given, of him shall much be required (B).

29 Scriptural expressions explained.

Upon these principles, we can easily explain all the passages in the New Testament concerning the *purpose*, the *election*, the *foreknowledge*, and the *predestination* of God. They relate to the design of calling the Gentile world to the knowledge of the Messias: This was kept secret, though hints had been given of it by several of the prophets, so that it was a mystery; but it was revealed when the apostles, in consequence of Christ's commission, *to go and teach all nations*, went about preaching the gospel to the Gentiles. This was a stumbling-block to the Jews, and it was the chief subject of dispute betwixt them and the apostles at the time when the Epistles were written: so that it was necessary for them to clear up this point very fully, and to mention it frequently. But in the beginning of Christianity there was no need of amusing men with high and unsearchable speculations concerning the decrees of God; the apostles therefore take up the point in dispute, the calling of the Gentiles in a general manner. They show, that Abraham at first, and Isaac and Jacob afterwards, were chosen by a discriminating favour, that they and their posterity should be in covenant with God; but that, nevertheless, it always was the intention of Providence to call in the Gentiles, tho' it was not executed till these later times.

With this key we can explain coherently the whole of St Paul's discourses upon this subject, without asserting antecedent and special decrees as to particular persons. Things that happen under a permissive and directing Providence, may, by a largeness of expression, be ascribed to the will and counsel of God; for a permissive will is really a will, though it is not the agent or cause of the effect. The *hardening of Pharaoh's heart* may be ascribed to God, though it is said that his *heart hardened itself*, because he took advantage of the respites which God granted him from the plagues, to encourage himself to longer resistance. Besides this, he was a cruel and bloody tyrant, and deserved such judgments for his other sins; so that he may be considered as at that time under final condemnation, and only preserved from the first plagues, to afford a striking instance of the avenging justice of God. That this is the meaning of the passage, appears extremely probable from the manner in which Exod. ix. 16. is rendered in the Vatican and Aldus's edit. of the LXX. Instead of saying, as in our translation, "And in very deed for this cause have I *raised thee up*, for to show in thee my power, &c." God is represented in that version as saying, "And in very deed for this cause have I *kept thee alive till now*, for to show," &c. *Whom he will he hardeneth*, is an expression that can only be applied to such persons as this tyrant was. It is obvious that the words of our Saviour concerning those *whom his Father had given him*, are only meant of a dispensation of Providence, and not of a decree; since he adds, And *I have lost none of them except the son of perdition*: for it cannot be said that *Judas Iscariot* was in the decree, and yet was lost. And in the same passage in which God is said *to work in us both to will and to do*, we are required *to work out our own salvation with fear and trembling*. The word *ordained* to eternal life also signifies fitted and disposed to eternal life. The question, *Who made thee to differ?* (1 Cor. iv. 7.) refers to those extraordinary gifts which, in different degrees and measures, were bestowed upon the first Christians, in which they were unquestionably passive.

30 Grace not irresistible.

If the decrees of God are not absolute, neither can his grace be so efficacious as absolutely and necessarily to determine our conduct, else why are we required *not to grieve God's spirit?* why is it said, *ye do always resist the Holy Ghost; as your fathers did, so do ye? How often*

(B) See Bishop Law's *Considerations on the Theory of Religion*, where this question is treated in a very masterly manner. The work, though less known than it ought to be, has great merit, and of the author we have given a biographical sketch in our ninth volume.

often would I have gathered you under my wings, and ye would not? What could I have done in my vineyard that has not been done in it? Theſe expreſſions indicate a power in us, by which we not only can, but often do, reſiſt the motions of grace. But if the determining efficacy of grace is not acknowledged, it will be much harder to believe that we are efficaciouſly determined to ſin. This ſuppoſition is ſo contrary both to the holineſs of God, and to the whole ſtyle of the ſacred writings, that it is unneceſſary to accumulate proofs of it. *O Iſrael, thou haſt deſtroyed thyſelf, but in me is thy help: ye will not come unto me that ye may have life: Why will you die, O houſe of Iſrael?*

31 As for perſeverance, we may remark, that the many promiſes made in the ſacred ſcriptures to them that *overcome*, that continue *ſtedfaſt and faithful to the death*, do certainly inſinuate that a man may fall from a good ſtate. The words of the apoſtle to the Hebrews are very clear and pointed: *For it is impoſſible for thoſe who were once enlightened, and have taſted of the heavenly gift, and were made partakers of the Holy Ghoſt, and have taſted the good word of God, and the powers of the world to come, if they ſhall fall away, to renew them again unto repentance* (Heb. vi. 4.) It is alſo ſaid, *The juſt ſhall live by faith: but if he draw* (c) *back, my ſoul ſhall have no pleaſure in him*, (Heb. x. 38.) And it is ſaid by the prophet, *When the righteous turneth away from his righteouſneſs, and committeth iniquity, all his righteouſneſs that he hath done ſhall not be mentioned; in his ſin that he hath ſinned ſhall he die*, (Ezek. viii. 24.) Theſe paſſages, with many others, give us every reaſon to believe that a good man may fall from a good ſtate, as well as that a wicked man may turn from a bad one.

32 We conclude the whole by obſerving, that the only difficulty which attends the queſtion ariſes from the myſterious, and apparently partial and unequal, courſe of the divine government in our preſent ſtate; but there is an important day approaching, when God will condeſcend to remove theſe obſcurities, and to vindicate the ways of his providence to man. On that great day, we are well aſſured, that the queſtion will be decided in our favour; for we know that judgment will be given, not according to any abſolute decree, but according to the deeds which we ourſelves ſhall have freely done in the body, whether they have been good, or whether they have been evil.

Thus have we ſtated, we hope with fairneſs and impartiality, a ſummary of the arguments on both ſides of this long agitated queſtion. We need hardly add, that it is a queſtion involved in conſiderable difficulties.—Milton, who was an eminent philoſopher and divine, as well as the firſt of poets, when he wiſhed to exhibit the fallen angels themſelves as perplexed by queſtions above their comprehenſion, ſet them to diſpute about predeſtination.

They reaſon'd high, of knowledge, will, and fate,
Fixed fate, free-will, fore-knowledge abſolute;
And found no end, in wand'ring mazes loſt.

Paradiſe Loſt.

Predeſtination || Predial.

33 The weak ſide of each doctrine.

The weak ſide of the Calviniſtic doctrine conſiſts in the impoſſibility of reconciling the abſolute and unconditional decree of reprobation with our ideas of the juſtice and goodneſs of God. The weak ſide of the Arminian ſcheme conſiſts in the difficulty of accounting for the certainty of the divine foreknowledge, upon the ſuppoſition of a contingency of events, or an abſolute freedom of will in man.

To elude the former of theſe difficulties, ſome of the late writers upon philoſophical neceſſity, and Dr Prieſtly is among the number, have given up the doctrine of reprobation, and aſſerted, that this world is only a ſtate of preparation for another, in which all men, of every deſcription and character, ſhall attain to final and everlaſting happineſs, when God *ſhall be all, and in all.*—On the other ſide, ſome of the ſupporters of free agency, and Monteſquieu * is among the number, have been diſpoſed to deny the divine attribute of preſcience.

* *Lettres Perſ.*

Whatever may be thought of the practical tendency of the two opinions, there is one remark which we think ourſelves bound in juſtice to make, although it appears to us to be ſomewhat ſingular. It is this, that from the earlieſt ages down to our own days, if we conſider the character of the ancient Stoics, the Jewiſh Eſſenes, the modern Calviniſts, and Janſeniſts, when compared with that of their antagoniſts the Epicureans, the Saducees, Arminians, and the Jeſuits, we ſhall find that they have excelled in no ſmall degree in the practice of the moſt rigid and reſpectable virtues, and have been the higheſt honour of their own ages, and the beſt models for imitation to every age ſucceeding. At the ſame time, it muſt be confeſſed, that their virtues have in general been rendered unamiable by a tinge of gloomy and ſevere auſterity.

So far as the ſpeculative foundation of their principles is conſidered, however, neither party ſeems liable to cenſure in a moral point of view. Each of them wiſhes to ſupport, though in a different manner from the other, the honour of the divine character. The Calviniſts begin their argument with the notion of infinite perfection, independency, and abſolute ſovereignty, and thence deduce their opinions; making every difficulty yield to theſe firſt and leading ideas. Their opponents are more jealous of the reſpect due to the divine attributes of juſtice, truth, holineſs, and mercy, and deduce their ſentiments from the idea which they have formed of theſe. Each party lays down general maxims that are admitted by the other, and both argue plauſibly from their firſt principles. Dr Burnet, whom we have here followed very cloſely, juſtly obſerves †, that "theſe are great grounds for mutual charity and forbearance." 34 Mutual forbearance recommended.

† *Expoſition of the 39 Articles.*

PREDETERMINATION, in philoſophy and theology, is that concurrence of God which makes men act, and determines them in all their actions, both good and evil, and is called by the ſchoolmen *phyſical predetermination* or *premotion*. See METAPHYSICS, Part III. Chap. v. and PREDESTINATION.

PREDIAL SLAVES. See *Predial-SLAVES.*

PRE-

(c) In our tranſlation we read, "If *any man* draw back," &c.; but the words *any man* are not in the original; and if they do not make nonſenſe of the text, they muſt at leaſt be acknowledged to obſcure its meaning.

Predial || Pre-exiſtence.

Predial-Tithes, are thoſe that are paid of things ariſing and growing from the ground only; as corn, hay, fruit, &c.

PREDICABLE, among logicians, denotes a general quality which may be predicated, or aſſerted of ſeveral things: thus animal is predicable of mankind, beaſts, birds, fiſhes, &c.

PREDICAMENT, among logicians, the ſame with category. See CATEGORY and PHILOSOPHY.

PREDICATE, in logic, that which, in a propoſition, is affirmed or denied of the ſubject. In theſe propoſitions, *ſnow is white, ink is not white;* whiteneſs is the predicate which is affirmed of ſnow, and denied of ink.

PRE-EMPTION, a privilege anciently allowed the king's purveyor, of having the choice and firſt buying of corn and other proviſions for the king's houſe; but taken away by the ſtatute 19 Car. II.

PREENING, in natural hiſtory, the action of birds cleaning, compoſing, and dreſſing their feathers, to enable them to glide more eaſily through the air. For this purpoſe they have two peculiar glands on their rump, which ſecrete an unctuous matter into a bag that is perforated, out of which the bird occaſionally draws it with its bill.

PRE-EXISTENCE, a priority of being, or the being of one thing before another. Thus a cauſe, if not in time, is yet in nature pre-exiſtent to its effect.

1 The Peripatetics maintained the eternity of the world.

Thus God is pre-exiſtent to the univerſe. Thus a human father is pre-exiſtent to his ſon. The Peripatetics, though they maintained the eternity of the world, were likewiſe dogmatical in their opinion, that the univerſe was formed, actuated, and governed, by a ſovereign intelligence. See *Ariſtotle on the Soul*, and our articles CREATION and EARTH. See alſo the *Philoſophical Eſſays of Dr Iſaac Watts*, and the *Principles of natural and revealed Religion*, by the Chevalier Ramſay, where the ſubject of the world's eternity is diſcuſſed. Mr Hume's ſpeculations alſo, on this abſtruſe and arduous ſubject, had a greater tendency to diſſipate its gloom than that philoſopher himſelf could imagine.

2 Pre-exiſtence of the ſoul taught by Aſiatic ſages.

The pre-exiſtence of the human ſoul to its corporeal vehicle had been from time immemorial a prevailing opinion among the Aſiatic ſages, and from them was perhaps transferred by Pythagoras to the philoſophy of the Greeks; but his metempſychoſis, or tranſmigration of ſouls, is too trivial either to be ſeriouſly propoſed or refuted. Nevertheleſs, from the ſentiments of Socrates concerning the immortality of the ſoul, delivered in his laſt interview with his friends, it is obvious that the tenet of pre-exiſtence was a doctrine of the Platonic ſchool. If at any period of life, ſay theſe philoſophers, you ſhould examine a boy, of how many ideas, of what a number of principles, of what an extent of knowledge, will you find him poſſeſſed: theſe without doubt could neither be ſelf-derived nor recently acquired. With what avidity and promptitude does he attain the knowledge of arts and ſciences, which appear entirely new to him! theſe rapid and ſucceſsful advances in knowledge can only be the effects of reminiſcence, or of a fainter and more indiſtinct ſpecies of recollection.

3 Socratic arguments for pre-exiſtence refuted.

But in all the other operations of memory, we find retroſpective impreſſions attending every object or idea which emerges to her view; nor does ſhe ever ſuggeſt any thought, word, or action, without informing us, in a manner equally clear and evident, that thoſe impreſſions have been made upon our ſenſes, mind, or intellect, on ſome former occaſion. Whoever contemplates her progreſs, will eaſily diſcover, that aſſociation is her moſt faithful and efficacious auxiliary; and that by joining impreſſion with impreſſion, idea with idea, circumſtance with circumſtance, in the order of time, of place, of ſimilarity or diſſimilarity, ſhe is capacitated to accumulate her treaſures and enlarge her province even to an indefinite extent. But when intuitive principles, or ſimple concluſions, are elicited from the puerile underſtanding by a train of eaſy queſtions properly arranged, where is the retroſpective act of memory, by which the boy recogniſes thoſe truths as having formerly been perceived in his mind? Where are the crowds of concomitant, antecedent, or ſubſequent ideas, with which thoſe recollections ought naturally to have been attended? In a word, where is the ſenſe of perſonal identity, which ſeems abſolutely inſeparable from every act of memory? This hypotheſis, therefore, will not ſupport pre-exiſtence.

4 Pre-exiſtence taught by Chr[iſtian] Platon[iſts].

After the Chriſtian religion had been conſiderably diffuſed, and warmly combated by its philoſophical antagoniſts, the ſame doctrine was reſumed and taught at Alexandria, by Platonic proſelytes, not only as a topic conſtituent of their maſter's philoſophy, but as an anſwer to thoſe formidable objections which had been deduced from the doctrine of original ſin, and from the vices which ſtain, and from the calamities which diſturb, human life: hence they ſtrenuouſly aſſerted, that all the human race were either introduced to being prior to Adam, or pre-exiſtent in his perſon; that they were not, therefore, repreſented by our firſt parents, but actually concurred in their crime, and participated their ruin.

The followers of Origen, and ſuch as entertained the notion of Pre-adamites *, might argue from the doctrine of pre-exiſtence with ſome degree of plauſibility. For the human beings introduced by them to the theatre of probation had already attained the capacity or dignity of moral agents; as their crime therefore was voluntary, their puniſhment might be juſt.

* See [Pre-]adamites.

5 But no [ſo]lution [of] origin[al ſin].

But thoſe who believe the whole human race created in Adam to be only pre-exiſtent in their germs or ſtamina, were even deprived of this miſerable ſubterfuge; for in theſe homunculi we can neither ſuppoſe the moral nor rational conſtitution unfolded. Since, therefore, their degeneracy was not ſpontaneous, neither could their ſufferings be equitable. Should it be ſaid that the evil of original ſin was penal, as it extended to our firſt parents alone, and merely conſequential as felt by their poſterity, it will be admitted that the diſtinction between penal and conſequential evil may be intelligible in human affairs, where other laws, aſſortments, and combinations than thoſe which are ſimply and purely moral, take place. But that a moral government, at one of the moſt cardinal periods of its adminiſtration, ſhould admit gratuitous or conſequential evil, ſeems to us irreconcileable with the attributes and conduct of a wiſe and juſt legiſlator. Conſequential evil, taken as ſuch, is miſery ſuſtained without demerit; and cannot reſult from the procedure of wiſdom, benignity, and juſtice; but muſt flow from neceſſity, from ignorance, from cruelty, or from caprice, as its only poſſible ſources. But even upon the ſuppoſition of thoſe who pretend

that man was mature in all his faculties before the commission of original sin, the objections against it will still remain in full force: for it is admitted by all except the Samian sage, that the consciousness of personal identity which was felt in pre-existence, is obliterated in a subsequent state of being.

Now it may be demanded, whether agents thus resuscitated for punishment have not the same right to murmur and complain as if they had been perfectly innocent, and only created for that dreadful catastrophe? It is upon this principle alone that the effects of punishment can be either exemplary or disciplinary; for how is it possible, that the punishment of beings unconscious of a crime should ever be reconciled either to the justice or beneficence of that intention with which their sufferings are inflicted? Or how can others be supposed to become wise and virtuous by the example of those who are neither acquainted with the origin nor the tendency of their miseries, but have every reason to think themselves afflicted merely for the sake of afflicting? To us it seems clear, that the nature and *rationale* of original sin lie inscrutably retired in the bosom of Providence; nor can we, without unpardonable presumption and arrogance, form the most simple conclusion, or attempt the minutest discovery, either different from or extraneous to the clear and obvious sense of revelation. This sense indeed may with propriety be extracted from the whole, or from one passage collated with another; but independent of it, as reason has no premisses, she can form no deductions. The boldness and temerity of philosophy, not satisfied with contemplating pre-existence as merely relative to human nature, has dared to try how far it was compatible with the glorious Persons of the sacred Trinity. The Arians, who allowed the subordinate divinity of our Saviour, believed him pre-existent to all time, and before all worlds; but the Socinians, who esteemed his nature as well as his person merely human, insisted, that before his incarnation he was only pre-existent in the divine idea, not in nature or person. But when it is considered, that children do not begin to deduce instructions from nature and experience, at a period so late as we are apt to imagine; when it is admitted, that their progress, though insensible, may be much more rapid than we apprehend; when the opportunities of sense, the ardour of curiosity, the avidity of memory, and the activity of understanding, are remarked—we need not have recourse to a pre-existent state for our account of the knowledge which young minds discover. It may likewise be added, that moral agents can only be improved and cultivated by moral discipline. Such effects therefore of any state, whether happy or miserable, as are merely mechanical, may be noxious or salutary to the patient, but can never enter into any moral economy as parts of its own administration. Pre-existence, therefore, whether rewarded or punished, without the continued impression of personal identity, affords no solution of original sin.

PREFACE, something introductory to a book, to inform the reader of the design, method, &c. observed therein, and generally whatever is necessary to the understanding of a book.

PREFECT, in ancient Rome, one of the chief magistrates who governed in the absence of the kings, consuls, and emperors.

This power was greatest under the emperors. His chief care was the government of the city, taking cognizance of all crimes committed therein and within 100 miles. He judged capitally and finally, and even presided in the senate. He had the superintendance of the provisions, building, and navigation.

The prefect of modern Rome differs little from the ancient *præfectus*, his authority only extending to 40 miles round the city.

PREFECT *of the Prætorium*, the leader of the pretorian bands destined for the emperor's guards, consisting, according to Dion, of 10,000 men. This officer, according to Suetonius, was instituted by Augustus, and usually taken from among the knights.

By the favour of the emperors his power grew very considerable; to reduce which, Constantine divided the prefecture of the prætorium into four prefectures, and each of these again he subdivided into civil and military departments, though the name was only reserved to him who was invested with the civil authority, and that of *comes belli* given him who commanded the cohorts.

PREGADI, in history, a denomination given to the senate of Venice, in which resides the whole authority of the republic. At its first institution it was composed of 60 senators, to whom 60 more have been added. See VENICE.

PREGNANCY, the state of a woman who has conceived, or is with child. See MIDWIFERY.

PREHNITE, a stone so named by Mr Werner, inspector of the mines of Freyburg, brought by Colonel Prehn from the Cape of Good Hope. In the first volume of *Chemical Annals* there is a chemical analysis of this stone extracted from the *Acta Naturæ Curiosorum*, Berlin, tom. viii. p. 211. an. 1788, part 2. by Klaproth; from which it appears, that 100 parts of prehnite contain silice

Silice	$43\frac{5}{8}$ grains.
Alumine	$30\frac{1}{3}$
Lime	$18\frac{1}{3}$
Oxyd of iron	$5\frac{2}{3}$
Water and air	$1\frac{1}{8}$
Total	100

Colonel Prehn gave it the name of emerald, and Mr Bruckmann adopted that denomination, but changed his opinion on considering that it had neither the hardness, the bright green colour, nor the property of crystallizing in hexagonal prisms like the emerald. The Dutch dealers call it *chrysoprasus* of the Cape; but chrysoprasus is nothing but quartz tinged green by the oxyd of nickel. Professor Haquet, in the 4th volume of the Berlin Transactions, has named it *crystallized prasus*. In the 8th volume, however, Mr Bruckmann considers it as a crystallized felt-spar. Mr Sage calls it *chrysolite*. Mr Rone de l'Isle classes it among the schoerls. To this classification Mr Klaproth objects, and is rather disposed with Mr Werner to consider it as a zeolite; on the whole, he thinks it may be conveniently ranked between zeolite and schoerl. Mr Hassenfratz published in the *Journal de Physique* for February 1788 an analysis of the same stone, under the title of *Pierre Silice, calcaire, alumineuse, &c. &c. de couleur verte, &c.* And according to his results, which are somewhat different from those of Mr Klaproth, and obtained by a different process, it contains, silice 50, lime 23.4, alumine 20.4, oxyd of iron 4.9, water 0.9, magnesia 0.5 = 100. The specific gravity of this stone, according to the experiments of Mr Brisson, is 2.9423. The dissection of its crystals, made by Abbé Haüy and Mr Hassenfratz, discovered one

Prejudice. one angle of 60 degrees, as in schoerls; but it has hitherto been impossible to determine the others. The Abbé Haüy has convinced himself, that it bears no resemblance to zeolite in its crystals. This stone scratches glass, and is itself scratched by rock crystal.

1 Definition. PREJUDICE, or PREJUDGMENT, from *præ* and *judicium*, means a judgment formed beforehand, without examination; the preposition *præ* expressing an anticipation, not so much of time as of knowledge and due attention: hence the schoolmen have called it *anticipation and a preconceived opinion*.

2 Origin of prejudice. Prejudice arises from the associating principle, which we have explained at large in another article (see METAPHYSICS, Part I. chap. 5.), and it is a weakness from which no human mind can be wholly free. Some are indeed much more than others under its influence; but there is no man who does not occasionally act upon principles, the propriety of which he never investigated; or who does not hold speculative opinions, into the truth of which he never seriously inquired. Our parents and tutors, yea our very nurses, determine a multitude of our sentiments: our friends, our neighbours, the custom of the country where we dwell, and the established opinions of mankind, form our belief; the great, the pious, the learned, and the ancient, the king, the priest, and the philosopher, are characters of mighty efficacy to persuade us to regulate our conduct by their practice, and to receive as truth whatever they may dictate.

The case cannot indeed be otherwise. The occasions of acting are so frequent, and the principles of action are so various, that were a man to investigate accurately the value of every single motive which presents itself to his mind, and to balance them fairly against each other, the time of acting would in most instances pass away long before he could determine what ought to be done; and life would be wasted in useless speculation. The great laws of religion and morality, which ought to be the general and leading principles of action, no man of science will take upon trust; but in the course of a busy life a thousand circumstances will occur in which we must act with such rapidity, that, after being satisfied of the lawfulness of what we are about to do, we must, for the prudence of it, confide entirely in the general customs of our country, or in the practice of other individuals placed in circumstances similar to ours. In all such cases, though we may act properly, we act from *prejudice*.

3 Its extensive dominion. But the dominion of prejudice is not confined to the actions of the man of business: it extends over the speculations of the philosopher himself, one half of whose knowledge rests upon no other foundation. All human sciences are related to each other (see PHILOSOPHY, n° 2.), and there is hardly one of them in which a man can become eminent unless he has some general acquaintance with the whole circle; but no man could ever yet investigate for himself all those propositions which constitute the circle of the sciences, or even comprehend the evidence upon which they rest, though he admits them perhaps as truths incontrovertible. He must therefore receive many of them upon the authority of others, or, which is the same thing, admit them by *prejudice*.

To this reasoning it may be objected, that when a man admits as true abstract propositions, which, though not self-evident, he cannot demonstrate, he admits them not by prejudice, but upon testimony, which has been elsewhere shown to be a sufficient foundation for human belief (see METAPHYSICS, n° 138.) The objection is plausible, but it is not solid; for testimony *commands* belief only concerning *events* which, falling under the cognizance of the senses, preclude all possibility of mistake; whereas abstract propositions, not self-evident, can be proved true only by a *process of reasoning* or by a *series of experiments*; and in conducting both these, the most vigorous mind is liable to mistake. When Sir Isaac Newton told the world that it was the fall of an apple which first suggested to him the general law of gravitation, he bore testimony to a fact concerning which he could not be mistaken; and we receive his testimony for the reasons assigned in the article referred to. When he lays down the method of obtaining the fluxion or momentum of the rectangle or product of two indeterminate quantities, which is the main point in his doctrine of fluxions, he labours to establish that method on the basis of demonstration; and whoever makes use of it in practice, without understanding that demonstration, receives the whole doctrine of the modern geometrical analysis, not as a matter of *fact* upon the credit of Sir Isaac's *testimony*, but as a system of abstract *truth* on the credit of his *understanding*: in other words, he is a fluxionist by *prejudice*.

In vain will it be said, that in mathematical demonstration there is no room for mistake; and that therefore the man who implicitly adopts the method of fluxions may be considered as relying upon the *veracity* of its author, who had no inducement to deceive him, and whose comprehension was confessedly greater than his. In fluxionary mathematics, which treat of matters of which it is extremely difficult, if not impossible, to have adequate and steady conceptions, the most comprehensive mind is liable to mistake: and it is well known that the celebrated bishop of Cloyne wrote his *Analyst* to prove that the incomparable author of the method of fluxions had committed *two mistakes* in his fundamental proposition, which balancing one another, produced a true conclusion by false reasoning. One or other of these great men, of whom the least was an eminent mathematician, must have been bewildered in his reasoning, and have fallen into error; and therefore whoever follows either of them implicitly without perceiving the error of the other, is unquestionably under the influence of prejudice. This is the case with the writer of the present article. He perceives not the error of Bishop Berkeley's reasoning, and yet he admits the doctrine of fluxions on the authority of Sir Isaac's demonstration. That demonstration, however, he pretends not to understand; and therefore he admits the doctrine through *prejudice*.

4 Impossible to eradicate all prejudices from the mind. We have made these observations to point out the absurdity of the fashionable cry against the harbouring of any prejudices. To eradicate all prejudices from the human mind is impossible; and if it were possible, it would be very unwise: for we see that prejudice may exist on the side of truth as well as on that of falsehood; and that principles professed and believed by any individual may be useful and true, though he was brought to them not by a train of fair and candid reasoning, but through the medium of prepossession or authority. Indeed such is our nature, and such are the laws of association,

...judice. sociation, that many of our best principles, and our obligation to perform many of the most amiable of our duties in common life, must evidently be acquired in this way. From endearing associations, and authoritative instruction, we acquire a knowledge of our duty to our parents, and a facility in performing it, together with the first principles of religion, without a single effort of our own reason. Even when reason has begun to assert its power, and shows us the propriety of such duties, we are wonderfully assisted in performing them by the amiable prejudices which we had before acquired, and which now appear to be natural to us. He who has never had the advantage of such associations, and who acquires a knowledge of the duties suggested by them after he has come to years of discretion, and chiefly by the efforts of his own reason, will seldom, *cæteris paribus*, perform those duties with an energy and delight equal to that of the person who has. This remark appears to be confirmed by experience; for it is often found, that the children of the great, who have been given out to nurse in their infancy, and who have seldom been in the company of their parents till their reasoning faculties have been far advanced, are much less dutiful and affectionate than those in the middle or lower stations of life, who have scarcely ever been out of their parents company.

5
...ich ...ld not ...ife if ...ere ...ible.

Would it then be wise, even if it were practicable, to dissolve all those associations which tend so powerfully to increase the mutual affections of parents and children? We cannot think that it would; as we believe it might be easily shown that public spirit springs out of private affection. Plato indeed held an opinion very different from ours; for in order to extend that affection which is usually lavished at home to the whole state, he proposed that children should be educated at the public expence, and never be permitted to know the authors of their being. But this is only one of the many visionary projects of that great man, of which daily experience shows the absurdity. In modern times, we are certain that less dependence is to be had upon the *patriotism* of the man who, for the love which he pretends to his country, can overlook or forget his own partial connections in it, than on him who, at the same time that he wishes his country well, is feelingly alive to all the endearments of kindred affection.

Such affection may be called *partial*, and very probably has its foundation in that which is the source of all our prejudices: but if it be properly trained in early life, it will gradually extend from our nearest relations to the persons with whom we associate, and to the place which not only gave us birth, but also furnished our youthful and most innocent enjoyments. It is thus that the *amor patriæ* is generated (see PASSION and PATRIOTISM), which in minds unseduced by false principles is exceedingly strong; and though a partial affection, is of the most general utility. It is this prejudice which reconciles the Laplander to his freezing snows, and the African to his burning sun; which attaches the native of the Highlands or of Wales as much to his mountains and rocks, as the apparently happier inhabitant of the southern counties of England is to the more fertile and delightful spot where he drew his first breath. And we find in fact, that when a native of Kent and a Scotch Highlander have in some distant corner of the world gained a competent fortune without

6
...d ef- ...of ...dices.

being corrupted by luxury, they return, the one to his hop-gardens, and the other to his mountains. Were this prejudice, for such it surely is, wholly eradicated from the human mind, it is obvious that large tracts of country which are now full of inhabitants would be totally deserted; and that the hungry barbarians, to make room for themselves, would exterminate the proprietors of more favourable climes. From an affection to our friends and to our country, we naturally contract an affection for that mode of government under which we live; and unless it be particularly oppressive to ourselves or any order of citizens, we come as naturally to prefer it to all other modes, whether it deserve that preference or not. This no doubt is prejudice, but it is a beneficial prejudice; for were the multitude, who are wholly incapable of estimating the excellencies and defects of the various modes of government, to become dissatisfied with their own, and rise in a mass to change it for the better, the most horrible consequences might justly be dreaded. Of this truth the present state of Europe affords too melancholy and convincing a proof. The man therefore who, under the pretence of enlightening the public mind and extirpating prejudices, paints to the illiterate vulgar, in aggravated colours, the abuse of that government which has hitherto protected them from the ferocity of each other, is one of the greatest criminals if his views be selfish, and one of the worst reasoners if they be disinterested, that human imagination can easily conceive.

Prejudice.

7
Danger of improper attempts to remove them.

With the selfish patriot we have at present no concern; but we may with propriety ask the disinterested lover of truth, whether he thinks it possible, that in a large community, of which nine-tenths of the members are necessarily incapable of taking comprehensive views of things, or feeling the force of political reasonings, any form of government can be acceptable to the people at large, which does not gain their affections through the medium of prejudice? It has been shown by Mr Hume with great strength of argument, that government is founded on *opinion*, which is of two kinds, viz. opinion of interest, and opinion of right. By opinion of interest, he understands the sense of the general advantage which is reaped from government, together with the persuasion that the particular government which is established is equally advantageous with any other that could easily be settled. The opinion entertained of the *right* of any government is always founded in its antiquity; and hence arises the passionate regard which under ancient monarchies the people have for the true heir of their royal family. These opinions, as held by the philosopher conversant with the history of nations, are founded upon reasoning more or less conclusive; but it is obvious, that in the minds of the multitude they can have no other foundation than prejudice. An illiterate clown or mechanic does not *see how* one form of government promotes the general interest more than another; but he may *believe* that it does, upon no other evidence than the declamation of a demagogue, who, for selfish purposes, contrives to flatter his pride. The same is the case with respect to the rights of hereditary monarchy. The anatomist finds nothing more in the greatest monarch than in the meanest peasant, and the moralist may perhaps frequently find less; but the true philosopher acknowledges his right to the sovereignty: and though he be weak in understanding, or infirm in years, would, for

Prejudice. the ſake of public peace and the ſtability of government, maintain him in his throne againſt every competitor of the moſt ſhining talents. The vulgar, however, who would act with this philoſopher, are influenced by no ſuch views, but merely by their prejudices in favour of birth and family; and therefore it is ridiculous to think of changing the public mind with reſpect to any form of government by pure reaſoning. In France a total change in the minds of the people has indeed been effected, and from the moſt violent prejudices in favour of royalty, they have now become more violently prejudiced in favour of republicaniſm. Bad as their government unqueſtionably was, the change that has now taken place is not the effect of calm reaſoning and accurate inquiry (for of that the bulk of mankind appears to be incapable), nor are their prejudices leſs violent than they were before. They are changed indeed; but no one will deny that prejudice, and that of the moſt violent kind, leads them on at preſent; nor can any one aſſert that their new prejudices have rendered them more happy, or their country more flouriſhing, than their former ones, which made them cry *Vive le Roi* under the tyrannic government of Louis XIV.

The influence of prejudice is not more powerful in fixing the political opinions of men, than in dictating their religious creed. Every child of a religious father receives his faith by inheritance long before he be capable of judging whether it be agreeable or diſagreeable to the word of God and the light of reaſon. This experience ſhows to be the fact; and ſound philoſophy declares that it cannot be otherwiſe. Parents are appointed to judge for their children in their younger years, and to inſtruct them in what they ſhould believe, and what they ſhould practiſe in the civil and religious life. This is a dictate of nature, and doubtleſs would have been ſo in a ſtate of perfect innocence. It is impoſſible that children ſhould be capable of judging for themſelves before their minds are furniſhed with a competent number of ideas, and before they are acquainted with any *principles* and *rules* of juſt reaſoning; and therefore they can do nothing better than run to their parents, and receive their directions what they ſhould believe and what they ſhould practiſe.

8 Abſurdity of keeping children ignorant of religion from the dread of prejudice.

This mode of tutoring the infant mind, and giving to our inſtructions the force of prejudice, before reaſon can operate with much effect, will, we know, be highly diſpleaſing to many who challenge to themſelves alone the epithet of liberal. With them it will be cramping the genius and perverting the judgment: but we cannot help thinking that ſuch an objection, if it ſhould be made, would be the offspring of ignorance; for it requires but very little knowledge of human nature to be able to ſee, that if children be not reſtrained by authority, and if we do not inſinuate a love of good principles into their minds, bad ones will inſinuate themſelves, and a little time will give *them* the force of inveterate prejudice, which all the future efforts of reaſon and philoſophy will find it difficult to eradicate. The idea of keeping a child ignorant of the being of a God, and the grand duties of morality and religion, till he ſhall come to years of diſcretion, and then allowing him to reaſon them out for himſelf, is an abſurd chimera: it is an experiment which never has been tried, which to us it appears impoſſible to try, and which, if it could be tried, could not poſſibly produce any good effect. For ſuppoſe we had a youth juſt arrived at years of diſcretion, totally ignorant of all theſe things, and unbiaſſed to any ſyſtem of opinions, or rather poſſeſſed of no opinions at all—it would, in the firſt place, we ſuſpect, be abſolutely neceſſary to direct his thoughts into a particular train, and for ſome perſon to lead him on from one idea to another, till he ſhould arrive at ſome concluſion: but in all this there is the influence of authority, aſſociation, and of prejudice.

9 Origin of bigotry.

It being therefore abſolutely neceſſary that ſentiments of religion be inſtilled into the minds of children before they be capable of diſcovering by the uſe of their reaſon whether thoſe ſentiments be juſt or not, it need not excite wonder, nor is it any reflection upon religion, that moſt men adhere with bigotry to the creed of their fathers, and ſupport that creed by arguments which could carry conviction to no minds but their own. The love and veneration which they bear to the memory of thoſe from whom they imbibed their earlieſt opinions, do not permit them to perceive either the falſehood of thoſe opinions, or their little importance, ſuppoſing them true. Hence the many frivolous diſputes which have been carried on among Chriſtians; and hence the zeal with which ſome of them maintain tenets which are at once contrary to ſcripture, to reaſon, and to common ſenſe. A due reflection, however, on the ſource of all prejudices ought to moderate this zeal; for no man is wholly free from that bias which he is ſo ready to condemn in others: and indeed a man *totally free from prejudice*, would be a more unhappy being than the moſt violent bigot on earth. In ſcience, he would admit nothing which he could not himſelf demonſtrate; in buſineſs, he would be perpetually at a ſtand for want of motives to influence his conduct: he could have no attachment to a particular country; and therefore muſt be without patriotiſm, and without the ſolaces of friendſhip; and his religion, we are afraid, would be cold and lifeleſs.

10 An objection answered.

What, it will be ſaid, are the authors of a work which profeſſes to enlighten the public mind by laying before it a general view of ſcience and literature, become at laſt the advocates of *prejudice*, which is the *bane* of *ſcience* and the *prop* of *ſuperſtition?* No, we are advocates for no prejudice which is either inimical to ſcience or friendly to abſurdity; but we do not think that the moraliſt would act wiſely who ſhould deſert his proper buſineſs to make himſelf maſter of the higher mathematics, merely that he might not be obliged to truſt occaſionally to the demonſtrations of others. The writer of this article is not ſkilled in trade; but it is not his opinion that the merchant would ſoon grow rich, who ſhould never make a bargain till he had previouſly calculated with mathematical exactneſs all the probabilities of his gain or loſs. That to diſſolve all the aſſociations which are the ſource of partial attachments of kindred, affection, and private friendſhip, would tend to promote the public happineſs, we cannot poſſibly believe. And we think, that the experience of the preſent eventful day abundantly confirms Mr Hume's opinion, that far from endeavouring to extirpate the people's prejudices in favour of birth and family, we ſhould cheriſh ſuch ſentiments, as being abſolutely requiſite to preſerve a due ſubordination in ſociety. That men would be better Chriſtians if they were to receive no religious inſtruction till they ſhould be able by their own reaſon to judge of its

its truth, daily obſervation does not warrant us to conclude; for we ſee thoſe who have ſeldom heard of God when children, "live without him in the world" when they are men.

Pernicious prejudices we have traced to their ſource elſewhere, and ſhown how they may be beſt prevented by proper attention in the education of children. (See METAPHYSICS, n° 98). We ſhall only add here, that the earlier ſuch attention is paid, the more effectual it will be found; and that it is much eaſier to keep prejudices out of the mind than to remove them after they have been admitted. This however muſt be ſometimes attempted; and where prejudices are ſtrong, ſeveral methods have been recommended for rendering the attempt ſucceſsful. The following are taken moſtly from Dr Watts's improvement of the mind.

1. Never attack the prejudice *directly*, but lead the perſon who is under its influence ſtep by ſtep to the truth. Perhaps your neighbour is under the influence of *ſuperſtition and bigotry in the ſimplicity of his ſoul*; you muſt not immediately run upon him with violence, and ſhow him the abſurdity or folly of his own opinions, though you might be able to ſet them in a glaring light; but you muſt rather begin at a diſtance, and eſtabliſh his aſſent to ſome familiar and eaſy propoſitions, which have a tendency to refute his miſtakes, and to confirm the truth; and then ſilently obſerve what impreſſion this makes upon him, and proceed by ſlow degrees as he is able to bear, and you muſt carry on the work perhaps at diſtant ſeaſons of converſation. The tender or diſeaſed eye cannot bear a deluge of light at once.

Overhaſtineſs and vehemence in arguing is oftentimes the effect of *pride*; it blunts the poignancy of the argument, breaks its force, and diſappoints the end. If you were to convince a perſon of the falſehood of the *doctrine of tranſubſtantiation*, and you take up the conſecrated bread before him and ſay, "You may ſee, and taſte, and feel, *this is nothing but bread*; therefore whilſt you aſſert that God commands you to believe *it is not bread*, you moſt wickedly accuſe God of commanding you to tell a lie." This ſort of language would only raiſe the indignation of the perſon againſt you, inſtead of making any impreſſions upon him. He will not ſo much as think at all on the argument you have brought, but he rages at you as a *profane wretch*, ſetting up your own ſenſe and reaſon above ſacred authority; ſo that though what you affirm is a truth of great evidence, yet you loſe the benefit of your whole argument by an ill management, and the unreaſonable uſe of it.

2. Where the prejudices of mankind cannot be conquered at once, but will riſe up in arms againſt the evidence of truth, there we muſt make ſome allowances, and yield to them for the preſent, as far as we can ſafely do it without real injury to truth; and if we would have any ſucceſs in our endeavours to convince the world, we muſt practiſe this complaiſance for the benefit of mankind. Take a ſtudent who has deeply imbibed the principles of the *Peripatetics*, and imagines certain immaterial beings, called *ſubſtantial forms*, to inhabit every herb, flower, mineral, metal, fire, water, &c. and to be the ſpring of all its properties and operations; or take a Platoniſt, who believes an *anima mundi*, "an univerſal ſoul of the world," to pervade all bodies, to act in and by them according to their nature, and indeed to give them their nature and their ſpecial powers; perhaps it may be very hard to convince theſe perſons by arguments, and conſtrain them to yield up thoſe fancies. Well then, let the one believe his *univerſal ſoul*, and the other go on with his notion of *ſubſtantial forms*, and at the ſame time teach them how by certain original laws of motion, and the various ſizes, ſhapes, and ſituations of the parts of matter, allowing a continued divine concourſe in and with all, the ſeveral appearances in nature may be ſolved, and the variety of effects produced, according to the corpuſcular philoſophy, improved by *Deſcartes*, *Mr Boyle*, and *Sir Iſaac Newton*; and when they have attained a degree of ſkill in this ſcience, they will ſee theſe airy notions of theirs, theſe imaginary powers, to be ſo uſeleſs and unneceſſary, that they will drop them of their own accord. The *Peripatetic forms* will vaniſh from the mind like a dream, and the *Platonic ſoul of the world will expire*.

We may give another inſtance of the ſame practice, where there is a prejudicate fondneſs of particular words and phraſes. Suppoſe a man is educated in an *unhappy form of ſpeech*, whereby he explains ſome *great doctrine of the goſpel*, and by the means of this phraſe he has imbibed a very falſe idea of that doctrine; yet he is ſo bigotted to his form of words, that he imagines if thoſe words are omitted the form is loſt. Now, if we cannot poſſibly perſuade him to part with his improper terms, we will indulge them a little, and try to explain them in a ſcriptural ſenſe, rather than let him go on in his miſtaken ideas. A perſon who has been bred a *Papiſt*, knows but little of religion, yet he reſolves never to part from the *Roman Catholic faith*, and is obſtinately bent againſt a change. Now it cannot be unlawful to teach ſuch an one the true Chriſtian, *i. e.* the *Proteſtant religion*, out of the *Epiſtle to the Romans*, and ſhow him that the ſame doctrine is contained in the *Catholic Epiſtles of St Peter*, *James*, *and Jude*; and thus let him live and die a good Chriſtian in the belief of the religion taught him out of the New Teſtament, while he imagines he is a *Roman Catholic* ſtill, becauſe he finds the doctrine he is taught in the *Catholic* Epiſtles and in that to the *Romans*. Sometimes we may make uſe of the very prejudices under which a perſon labours, in order to convince him of ſome particular truth, and argue with him upon his own profeſſed principles as though they were true. Suppoſe a *Jew* lies ſick of a fever, and is forbid fleſh by his phyſician; but hearing that rabbits were provided for the dinner of the family, deſired earneſtly to eat of them; and ſuppoſe he became impatient, becauſe his phyſician did not permit him, and he inſiſted upon it that it could do him no hurt—ſurely rather than let him perſiſt in that fancy and that deſire, to the danger of his life, we might tell him that theſe animals were ſtrangled, a ſort of food forbidden by the Jewiſh law, though we ourſelves might believe that law to be aboliſhed.

Where we find any perſon obſtinately perſiſting in a miſtake in oppoſition to all reaſon, eſpecially if the miſtake be very injurious or pernicious, and we know this perſon will hearken to the ſentiment or authority of ſome favourite name; it is needful ſometimes to urge the *opinion and authority* of that favourite perſon, ſince that is likely to be regarded much more than *reaſon*. We are almoſt aſhamed indeed to ſpeak of uſing any *influence of authority* in reaſoning or argument; but in ſome

Prejudice || Premonstrantes. cases it is better that poor, silly, perverse, obstinate creatures, should be persuaded to judge and act right, by a veneration for the sense of others, than to be left to wander in pernicious errors, and continue deaf to all argument, and blind to all evidence. They are but children of a larger size; and since they persist all their lives in their minority, and reject all true reasoning, surely we may try to persuade them to practise what is for their own interest by such childish reasons as they will hearken to. We may overawe them from pursuing their own ruin by the terrors of a solemn shadow, or allure them by a sugar plum to their own happiness. But after all, we must conclude, that wheresoever it can be done, it is best to *remove and root out those prejudices* which obstruct the entrance of truth into the mind, rather than to palliate, humour, or indulge them; and sometimes this must necessarily be done, before you can make a person part with some beloved error, and lead him into better sentiments.

12 Mutual forbearance recommended. On the whole, we would recommend more mutual forbearance and less acrimony than is commonly found among writers on disputed subjects, as the only means by which our differences in religion, politics, and science, ever can be healed, and truth certainly discovered. If men were less violent in defending their particular opinions, they would always gain a more patient hearing, they would be less suspected of, and less liable to, prejudice; and of course more apt either to convince or to be convinced. They would likewise by so doing show, in the most unequivocal manner, their attention to sound philosophy, and above all to genuine Christianity; which, though it is far from encouraging scepticism, or a temporizing spirit, recommends, in the strongest terms, among all its professors, *universal charity and mutual forbearance*. See PROBABILITY, TRUTH, and SUPERSTITION.

PRELATE, an ecclesiastic raised to some eminent and superior dignity in the church; as bishops, archbishops, patriarchs, &c.

PRELIMINARY, in general, denotes something to be examined and determined before an affair can be treated of to the purpose.

PRELUDE, in music, is usually a flourish or irregular air, which a musician plays off-hand, to try if his instrument be in tune, and so lead him into the piece to be played.

PREMISSES, in logic, an appellation given to the two first propositions of a syllogism. See LOGIC.

PREMISSES, in law, properly signifies the land, &c. mentioned in the beginning of a deed.

PREMIUM, or PRÆMIUM, properly signifies a reward or recompense: but it is chiefly used in a mercantile sense for the sum of money given to an insurer, whether of ships, houses, lives, &c. See INSURANCE.

PREMNA, in botany; a genus of the angiospermia order, belonging to the didynamia class of plants. The calyx is bilobed; the corolla quadrifid; the berry quadrilocular; the seeds solitary.

PREMONSTRANTES, or PRÆMONSTRATENSES, a religious order of regular canons instituted in 1120, by S. Norbert; and thence also called *Norbertines*.

The first monastery of this order was built by Norbert in the Isle of France, three leagues to the west of Laon; which he called *Præmonstre*, *Præmonstratum*, and hence the order itself derived its name; though as to the occasion of that name, the writers of that order are divided. At first the religious of this order were so very poor, that they had only a single ass, which served to carry the wood they cut down every morning, and sent to Laon in order to purchase bread. But they soon received so many donations, and built so many monasteries, that in 30 years after the foundation of the order, they had above 100 abbeys in France and Germany; and in process of time the order so increased, that it had monasteries in all parts of Christendom, amounting to 1000 abbeys, 300 provostships, a vast number of priories, and 500 nunneries. But they are now greatly diminished. The rule they followed was that of St Augustine, with some slight alterations, and an addition of certain severe laws, whose authority did not long survive their founder.

The order was approved by Honorius II. in 1126, and again by several succeeding popes. At first the abstinence from flesh was rigidly observed. In 1245 Innocent IV. complained of its being neglected to a general chapter. In 1288, their general, William, procured leave of pope Nicholas IV. for those of the order to eat flesh on journeys. In 1460, Pius II. granted them a general permission to eat meat, excepting from Septuagesima to Easter. The dress of the religious of this order is white, with a scapulary before the cassock. Out of doors they wear a white cloak and white hat; within, a little camail; and at church, a surplice, &c.

In the first monasteries built by Norbert, there was one for men and another for women, only separated by a wall. In 1137, by a decree of a general chapter, this practice was prohibited, and the women removed out of those already built, to a greater distance from those of the men.

The Præmonstratenses, or monks of Premontre, vulgarly called *white canons*, came first into England, A. D. 1146. Their first monastery, called *New-house*, was erected in Lincolnshire, by Peter de Saulia, and dedicated to St Martial. In the reign of Edward I. this order had 27 monasteries in England.

PRENANTHES, in botany: A genus of the polygamia æqualis order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, *Compositæ*. The receptacle is naked; the calyx calyculated; the pappus is simple, and almost sessile; the florets are placed in a single series.

PRENOMEN, PRÆNOMEN, among the ancient Romans, a name prefixed to their family name, and answering to our Christian name: such are Caius, Lucius, Marcus, &c.

PRENOTION, PRÆNOTIO, or *Præcognitio*, is a notice or piece of knowledge preceding some other in respect of time. Such is the knowledge of the antecedent, which must precede that of the conclusion. It is used by Lord Bacon for breaking of an endless search, which he observes to be one of the principal parts of the art of memory. For when one endeavours to call any thing to mind, without some previous notion or perception of what is sought for, the mind exerts itself and strives in an endless manner: but if it hath any short notion before-hand, the infinity of the search is presently cut off, and the mind hunts nearer home, as in an inclosure. Thus verse is easier remembered than prose; because if we stick at any word in a verse, we have

have a previous notion that it is ſuch a word as muſt ſtand in a verſe. Hence alſo, order is a manifeſt help to memory; for here is a previous notion, that the thing ſought for muſt be agreeable to order. Bacon's *Works Abr*. vol. i. p. 136. and vol. ii. p. 473.

PREPARATION, in a general ſenſe, the act of diſpoſing things in ſuch a manner as to render any foreſeen event more advantageous or leſs hurtful according to its nature.

Preparation *of Diſſonances*, in muſic, is their diſpoſition in harmony in ſuch a manner, that, by ſomething congenial in what precedes, they may be rendered leſs harſh to the ear than they would be without that precaution: according to this definition, every diſcord ought to be prepared. But when, in order to prepare a diſſonance, it is exacted that the ſound which forms it ſhould before have formed a conſonance, then there is fundamentally but one ſingle diſſonance which is prepared, viz. the ſeventh. Nor is even this preparation neceſſary in the chord which contains the ſenſible note, becauſe then the diſſonance being characteriſtical, both in its chord and in its mode, the ear has ſufficient reaſon to expect it: it accordingly does expect it, and recogniſe it; nor is either deceived with reſpect to its chord nor its natural progreſs. But when the ſeventh is heard upon a fundamental ſound which is not eſſential to the mode, it ought then to be prepared, in order to prevent all ambiguity; to prevent the ear, whilſt liſtening to this note, from loſing its train: and as this chord of the ſeventh may be inverted and combined in ſeveral different manners, from this ariſe likewiſe a number of different ways by which it may ſeem to be prepared, which, in the main, always iſſue however in the ſame thing.

In making uſe of diſſonances, three things are to be conſidered; viz. the chord which precedes the diſſonance, that in which it is found, and that which is immediately ſubſequent to it. Preparation only reſpects the two firſt; for the third, ſee Resolution.

When we would regularly prepare a diſcord in order to arrive at its chord, we muſt chooſe ſuch a career of the fundamental baſs, that the ſound which forms the diſſonance may be a protraction into the perfect time of the ſame note which formed a conſonance formerly ſtruck in the imperfect in the preceding chord; this is what we call *ſincopation*. See Sincopation.

From this preparation two advantages reſult; viz. 1. That there is neceſſarily an harmonical connection between the two chords, ſince that connection is formed by the diſſonance itſelf; and, 2. That this diſſonance, as it is nothing elſe but the continuation of the ſame ſound which had formed a conſonance, becomes much leſs harſh to the ear than it would have been with any ſound recently ſtruck. Now this is all that we expect to gain by preparation. See Cadence, Discord, and Harmony.

By what has been juſt ſaid, it will appear that there is no other part peculiarly deſtined for preparing the diſſonance, except that in which it is heard; ſo that if the treble ſhall exhibit a diſſonance, that muſt be ſincopated; but if the diſſonance is in the baſs, the baſs muſt be ſincopated. Though there is nothing here but what is quite ſimple, yet have maſters of muſic miſerably embroiled the whole matter.

Some diſſonances may be found which are never prepared: ſuch is the ſixth ſuperadded: ſome which are very unfrequently prepared; ſuch is the diminiſhed ſeventh.

Preparations, in pharmacy, the medicines when mixed together in ſuch a manner as to be fit for the uſe of the patient. See Pharmacy, Part II.

Preparations, in anatomy, the parts of animal bodies prepared and preſerved for anatomical uſes.

The manner of preſerving anatomical preparations, is either by drying them thoroughly in the air, or putting them into a proper liquor.

In drying parts which are thick, when the weather is warm, care muſt be taken to prevent putrefaction, fly-blows, inſects, &c. This is eaſily done by the uſe of a ſolution of corroſive ſublimate in ſpirit of wine, in the proportion of two drams of ſublimate to a pound of ſpirit: the part ſhould be moiſtened with this liquor as it dries, and by this method the body of a child may be kept ſafe even in ſummer. Dried preparations are apt to crack and moulder away in keeping; to prevent this, their ſurface ſhould be covered with a thick varniſh, repeated as often as occaſion requires. *Edin. Med. Eſſays, vol. ii. p.*

Though ſeveral parts prepared dry are uſeful, yet others muſt be ſo managed as to be always flexible, and nearer a natural ſtate. The difficulty has been to find a proper liquor for this purpoſe. Dr Monro ſays, the beſt he knows is a well rectified colourleſs ſpirit of wine, to which is added a ſmall quantity of the ſpirit of vitriol or nitre. When theſe are properly mixed, they neither change their colour nor the conſiſtence of the parts, except where there are ſerous or mucous liquors contained in them. The brain, even of a young child, in this mixture grows ſo firm as to admit of gentle handling, as do alſo the vitreous and cryſtalline hnmours of the eye. The liquor of the ſebaceous glands and the ſemen are coagulated by this ſpirituous mixture; and it heightens the red colour of the injection of the blood-veſſels, ſo that after the part has been in it a little time, ſeveral veſſels appear which were befor inviſible. If you will compare theſe effects with what Ruyſch has ſaid of his balſam, you will find the liquor above-mentioned to come very near to it.

The proportion of the two ſpirits muſt be changed according to the part prepared. For the brain and humours of the eye, you muſt put two drams of ſpirit of nitre to one pound of ſpirit of wine. In preſerving other parts which are harder, 30 or 40 drops of the acid will be ſufficient; a larger quantity will make bones flexible, and even diſſolve them. The part thus preſerved ſhould be always kept covered with the liquor: therefore great care ſhould be taken to ſtop the mouth of the glaſs with a waxed cork and a bladder tied over it, to prevent the evaporation of the ſpirit; ſome of which, notwithſtanding all this care, will fly off; therefore freſh muſt be added as there is occaſion. When the ſpirits change to a dark tincture, which will ſometimes happen, they ſhould be poured off, and freſh put in their room; but with ſomewhat leſs acid than at firſt.

The glaſſes which contain the preparations ſhould be of the fineſt ſort, and pretty thick; for through ſuch the parts may be ſeen very diſtinctly, and of a true colour, and the object will be ſo magnified as to

ſhow

fhow veffels in the glafs which out of it were not to be feen.

As the glafs when filled with the liquor has a certain focus, it is neceffary to keep the preparation at a proper diftance from the fides of it, which is eafily done by little fticks fuitably placed, or by fufpending it by a thread in a proper fituation. The operator fhould be cautious of putting his fingers in this liquor oftener than is abfolutely neceffary; becaufe it brings on a numbnefs on the fkin, which makes the fingers unfit for any nice operation. The beft remedy for this is to wafh them in water mixed with a few drops of oil of tartar per deliquium.

Dr Chrift. Jac. Trew prefers the rectified fpirit of grain for preferving anatomical preparations to fpirit of wine, or to compofitions of alcohol, amber, camphor, &c. becaufe thefe foon change into a brown colour, whereas the fpirit from malt preferves its limpid appearance. When any part is to be preferved wet, wafh it with water till it is no more tinctured. The water is next to be wafhed away with fpirits, and then the preparation is to be put among fpirits in a glafs, the mouth of which is to be clofely covered with a glafs head, over which a wet bladder and leaf-tin are to be tied. *Com. Lit. Norimb.* 1731. *femeft.* 1. *fpecim.* 9. See alfo *Pole's Anatomical Inftructor*, and *American Tranfactions*, vol ii. p. 366.

PREPENSED, in law, denotes fore-thought. In which fenfe we fay *prepenfed malice*, &c. If, when a man is flain upon a fudden quarrel, there were malice prepenfed formerly between them, it makes it murder; and, as it is called in fome ftatutes, *prepenfed murther*.

PREPOSITION, in grammar, one of the parts of fpeech, being an indeclinable particle which yet ferves to govern the nouns that follow it; fuch as *per*, *pro*, *propter*; and through, for, with, &c.

F. Buffier allows it to be only a modificative of a part of fpeech, ferving to circumftantiate a noun.

PREPUCE, in anatomy, the forefkin, being a prolongation of the cutis of the penis, covering the glans. See ANATOMY, n° 107.

PREROGATIVE, an exclufive or peculiar privilege.

Royal PREROGATIVE, that fpecial pre-eminence which the king hath over and above all other perfons, and out of the ordinary courfe of the common law, in right of his regal dignity. It fignifies in its etymology (from *præ* and *rogo*) fomething that is required or demanded before, or in preference to, all others. And hence it follows, that it muft be in its nature fingular and eccentrical; that it can only be applied to thofe rights and capacities which the king enjoys alone in contradiftinction to others, and not to thofe which he enjoys in common with any of his fubjects: for if once any one prerogative of the crown could be held in common with the fubject, it would ceafe to be prerogative any longer. And therefore Finch lays it down as a maxim, that the prerogative is that law in cafe of the king, which is law in no cafe of the fubject.

Prerogatives are either *direct* or *incidental*. The *direct* are fuch pofitive fubftantial parts of the royal character and authority, as are rooted in, and fpring from, the king's political perfon, confidered merely by itfelf, without reference to any other extrinfic circumftance; as, the right of fending ambaffadors, of creating peers, and of making war or peace. But fuch prerogatives as are *incidental* bear always a relation to fomething elfe, diftinct from the king's perfon; and are indeed only exceptions, in favour of the crown, to thofe general rules that are eftablifhed for the reft of the community: fuch as, that no cofts fhall be recovered againft the king; that the king can never be a joint tenant; and that his debt fhall be preferred before a debt to any of his fubjects.

Thefe fubftantive or direct prerogatives may again be divided into three kinds: being fuch as regard, firft, the king's royal *character* or *dignity*; fecondly, his royal *authority* or *power*; and, laftly, his royal *income*. Thefe are neceffary, to fecure reverence to his perfon, obedience to his commands, and an affluent fupply for the ordinary expences of government; without all of which it is impoffible to maintain the executive power in due independence and vigour. Yet, in every branch of this large and extenfive dominion, our free conftitution has interpofed fuch feafonable checks and reftrictions, as may curb it from trampling on thofe liberties which it was meant to fecure and eftablifh. The enormous weight of prerogative, if left to itfelf, (as in arbitrary governments it is), fpreads havock and deftruction among all the inferior movements: but, when balanced and bridled (as with us) by its proper counterpoife, timely and judicioufly applied, its operations are then equable and regular; it invigorates the whole machine, and enables every part to anfwer the end of its conftruction.

I. Of the royal *dignity*. Under every monarchical eftablifhment, it is neceffary to diftinguifh the prince from his fubjects, not only by the outward pomp and decorations of majefty, but alfo by afcribing to him certain qualities as inherent in his royal capacity, diftinct from, and fuperior to, thofe of any other individual in the nation. For though a philofophical mind will (fays Sir William Blackftone) confider the royal perfon merely as one man appointed by mutual confent to prefide over many others, and will pay him that reverence and duty which the principles of fociety demand; yet the mafs of mankind will be apt to grow infolent and refractory, if taught to confider their prince as a man of no greater perfection than themfelves. — The law therefore afcribes to the king, in his high political character, not only large powers and emoluments, which form his prerogative and revenue, but likewife certain attributes of a great and tranfcendent nature; by which the people are led to confider him in the light of a fuperior being, and to pay him that awful refpect which may enable him with greater eafe to carry on the bufinefs of government. This is what we underftand by the royal dignity; the feveral branches of which we fhall now proceed to enumerate.

1. And, firft, the law afcribes to the king the attribute of *fovereignty*, or pre-eminency. See SOVEREIGNTY.

2. "The law alfo (according to Sir William Blackftone) afcribes to the king, in his political capacity, abfolute *perfection*. 'The king can do no wrong.' Which ancient and fundamental maxim (fays he) is not to be underftood as if every thing tranfacted by the government was of courfe juft and lawful; but means only two things. Firft, that whatever

is

is exceptionable in the conduct of public affairs, is not to be imputed to the king, nor is he answerable for it personally to his people: for this doctrine would totally destroy that constitutional independence of the crown, which is necessary for the balance of power, in our free and active, and therefore compounded, constitution. And, secondly, it means that the prerogative of the crown extends not to do any injury; it is created for the benefit of the people, and therefore cannot be exerted to their prejudice.—" The king, moreover, (he observes), is not only incapable of *doing* wrong, but even of *thinking* wrong: he can never mean to do an improper thing: in him is no folly or weakness. And, therefore, if the crown should be induced to grant any franchise or privilege to a subject contrary to reason, or in anywise prejudicial to the commonwealth or a private person, the law will not suppose the king to have meant either an unwise or an injurious action, but declares that the king was deceived in his grant; and thereupon such grant is rendered void, merely upon the foundation of fraud and deception, either by or upon those agents whom the crown has thought proper to employ. For the law will not cast an imputation on that magistrate whom it entrusts with the executive power, as if he was capable of intentionally disregarding his trust: but attributes to mere imposition (to which the most perfect of sublunary beings must still continue liable) those little inadvertencies, which, if charged on the will of the prince, might lessen him in the eyes of his subjects."

Prerogative.

But this doctrine has been exposed as ridiculous and absurd, by Lord Abingdon, in his *Dedication to the collective Body of the People of England*. " Let us see (says he) how these maxims and their comments agree with the constitution, with nature, with reason, with common sense, with experience, with fact, with precedent, and with Sir William Blackstone himself; and whether, by the application of these rules of evidence thereto, it will not be found, that (from the want of attention to that important line of distinction which the constitution has drawn between the *king* of England and the *crown* of England) what was attributed to the *monarchy* has not been given to the *monarch*, what meant for the *kingship* conveyed to the *king*, what designed for the *thing* transferred to the *person*, what intended for *theory* applied to *practice*; and so in consequence, that whilst the premisses (of the perfection of the monarchy) be true, the conclusion (that the king can do no wrong) be not false.

" And, first, in reference to the constitution; to which if this matter be applied (meaning what it expresses, and if it do not it is unworthy of notice), it is subversive of a principle in the constitution, upon which the preservation of the constitution depends; I mean the principle of *resistance*; a principle which, whilst no man will now venture to gainsay, Sir William Blackstone himself admits, ' *is justifiable to the person of the prince*, when the being of the state is endangered, and the public voice proclaims such resistance necessary;' and thus, by such admission, both disproves the maxim, and oversets his own comment thereupon: for to say that ' the king can do no wrong,' and that ' he is incapable even of thinking wrong,' and then to admit that ' resistance to his person is justifiable,' are such jarring contradictions in themselves, that, until reconciled, the necessity of argument is suspended.

" With respect then, in the next place, to the agreement of this maxim, and its comment, with nature, with reason, and with common sense, I should have thought myself sufficiently justified in appealing to every man's own reflection for decision, if I had not been made to understand that nature, reason, and common sense, had had nothing to do with either. Sir William Blackstone says, ' That though a philosophical mind will consider the royal person merely as one man appointed by mutual consent to preside over others, and will pay him that reverence and duty which the principles of society demand, yet the mass of mankind will be apt to grow insolent and refractory if taught to consider their prince as a man of no greater perfection than themselves; and therefore the law ascribes to the king, in his high political character, certain attributes of a great and transcendent nature, by which the people are led to consider him in the light of a superior being, and to pay him that awful respect which may enable him with greater ease to carry on the business of government.' So that, in order to govern with greater ease (which by the bye is mere assertion without any proof), it is necessary to deceive the mass of mankind, by making them believe, not only what a philosophical mind cannot believe, but what it is impossible for any mind to believe; and therefore, in the investigation of this subject, according to Sir William, neither nature, reason, nor common sense, can have any concern.——

" It remains to examine in how much this maxim and its comment agree with experience, with fact, with precedent, and with Sir William Blackstone himself. And here it is matter of most curious speculation, to observe a maxim laid down, and which is intended for a rule of government, not only without a single case in support of it, but with a string of cases, that may be carried back to Egbert the first monarch of England, in direct opposition to the doctrine. Who is the man, that, reading the past history of this country, will show us any king that has done no wrong? Who is the reader that will not find, that all the wrongs and injuries which the free constitution of this country has hitherto suffered, have been solely derived from the arbitrary measures of our kings? And yet the mass of mankind are to look upon the king as a superior being; and the maxim, that ' the king can do no wrong,' is to remain as an article of belief. But, without pushing this inquiry any farther, let us see what encouragement Sir William Blackstone himself has given us for our credulity. After stating the maxim, and presenting us with a most lively picture, ' of our sovereign lord thus *all perfect* and *immortal*,' what does he make this all-perfection and immortality in the end to come to? His words are these: ' For when king Charles's deluded brother attempted to *enslave* the nation,' (*no wrong this, to be sure*), ' he found it was beyond his power: the people both *could*, and *did*, resist him; and in consequence of such resistance, obliged him to quit his enterprise and his throne together *."

The sum of all is this: That the crown of England and the king of England are distinguishable, and not synonymous terms: that allegiance is due *to the crown*, and through the crown *to the king*: that the attributes of

* Comment. vol. iv p. 433.

Prerogative.

of the crown are ſovereignty, perfection, and perpetuity; but that it does not therefore follow that the king can do no wrong. It is indeed to be admitted, that in high reſpect for the crown, high reſpect is alſo due to the wearer of that crown; that is, to the king: but the crown is to be preferred to the king, for the firſt veneration is due to the conſtitution. It is likewiſe *to be ſuppoſed* that the king *will* do no wrong: and as, to prevent this, a privy council is appointed by the conſtitution to aſſiſt the king in the execution of the government; ſo if any wrong be done, 'theſe men,' as Monteſquieu expreſſes it, 'may be examined and puniſhed (A).'

"But if any future king ſhall think to ſcreen theſe evil counſellors from the juſt vengeance of the people, by becoming *his own miniſter*; and, in ſo doing, ſhall take for his ſanction *the attribute of perfection*, ſhall truſt to the deception of his being *a ſuperior being*, and cloak himſelf under the maxim that *the king can do no wrong*; I ſay, in ſuch a caſe, let the appeal already made to the conſtitution, to nature, to reaſon, to common ſenſe, to experience, to fact, to precedent, and to Sir William Blackſtone himſelf, ſuffice; and preclude the neceſſity of any further remarks from me (B)."

To proceed now to other particulars: The law determines, that in the king can be no negligence, or LACHES; and therefore no delay will bar his right. *Nullum tempus occurrit regi*, is the ſtanding maxim upon all occaſions: for the law intends that the king is always buſied for the public good, and therefore has not leiſure to aſſert his right within the times limited to ſubjects. In the king alſo can be no ſtain or corruption of blood: for if the heir to the crown were attainted of treaſon or felony, and afterwards the crown ſhould deſcend to him, this would purge the attainder *ipſo facto*. And therefore, when Henry VII. who as earl of Richmond ſtood attainted, came to the crown, it was not thought neceſſary to paſs an act of parliament to reverſe this attainder; becauſe, as Lord Bacon in his hiſtory of that prince informs us, it was agreed that the aſſumption of the crown had at once purged all attainders. Neither can the king, in judgment of law, as king, ever be a minor or under age; and therefore his royal grants and aſſents to acts of parliament are good, though he has not in his natural capacity attained the legal age of 21. By a ſtatute, indeed, 28 Hen. VIII. c. 17. power was given to future kings to reſcind and revoke all acts of parliament that ſhould be made while they were under the age of 24: but this was repealed by the ſtatute 1 Edward VI. c. 11. ſo far as related to that prince, and both ſtatutes are declared to be determined by 24 Geo. II. c. 24. It hath alſo been uſually thought prudent, when the heir-apparent has been very young, to appoint a protector, guardian, or regent, for a limited time: but the very neceſſity of ſuch extraordinary proviſion is ſufficient to demonſtrate the truth of that maxim of common law, that in the king is no minority; and therefore he hath no legal guardian. See REGENT.

Blackſt. Comment.

3. A third attribute of the king's majeſty is his *perpetuity*. The law aſcribes to him, in his political capacity, an abſolute immortality. The king never dies. Henry, Edward, or George, may die; but the king ſurvives them all. For, immediately upon the deceaſe of the reigning prince in his natural capacity, his kingſhip or imperial dignity, by act of law, without any *interregnum* or interval, is veſted at once in his heir; who is, *eo inſtanti*, king to all intents and purpoſes. And ſo tender is the law of ſuppoſing even a poſſibility of his death, that his natural diſſolution is generally called his *demiſe*; *dimiſſio regis vel coronæ*: an expreſſion which ſignifies merely a transfer of property; for, as is obſerved in Plowden, when we ſay the demiſe of the crown, we mean only, that, in conſequence of the diſunion of the king's body-natural from his body-politic, the kingdom is transferred or demiſed to his ſucceſſor, and ſo the royal dignity remains perpetual. Thus, too, when Edward the fourth, in the tenth year of his reign, was driven from his throne for a few months by the houſe of Lancaſter, this temporary transfer of his dignity was denominated his *demiſe*; and all proceſs was held to be diſcontinued, as upon a natural death of the king.

II. We are next to conſider thoſe branches of the royal prerogative which inveſt this our ſovereign lord with a number of *authorities* and *powers*; in the exertion whereof conſiſts the executive part of government. This is wiſely placed in a ſingle hand by the Britiſh conſtitution, for the ſake of unanimity, ſtrength, and diſpatch. Were it placed in many hands, it would be ſubject to many wills: many wills, if diſunited and drawing different ways, create weakneſs in a government; and to unite thoſe ſeveral wills, and reduce them to one, is a work of more

(A) Except the parliament, which is the great council of the nation, the judges, and the peers, who, being the hereditary counſellors of the crown, have not only a right, but are bound *in foro conſcientiæ* to adviſe the king for the public good, the conſtitution knows of no other counſel than the privy council. Any other counſel, like Clifford, Arlington, Buckingham, Aſhley, Lauderdale, and, as the initial letters of theſe names expreſs, is a CABAL, and as ſuch ſhould be ſuppreſſed. Nat. Bacon, ſpeaking of the loſs of power in the grand council of lords, ſays, "The ſenſe of ſtate once contracted into a privy-council, is ſoon recontracted into a cabinet-council, and laſt of all into a *favourite* or two; which many times brings damage to the public, and both *themſelves* and *kings* into extreme *precipices*; partly for want of maturity, but principally through the providence of God over-ruling irregular courſes to the hurt of ſuch as walk in them." *Pol. Diſc.* part 2. p. 201.

(B) For experience, fact, and precedent, ſee the reigns of king John, Henry III. Edward. II. Richard II. Charles I. and James II. See alſo *Mirror of Juſtices*; where it is ſaid, "that this grand aſſembly (meaning the now parliament, or then Wittena-gemotte) is to confer the government of God's people, how they may be kept from ſin, live in quiet, and have right done them, according to the cuſtoms and laws; and more eſpecially *of wrong done by the king*, queen, or their children:" to which Nat. Bacon adds this note: "At this time *the king might do wrong*, &c. and ſo ſay Bracton and Fleta of the *kings* in their time." *Diſc.* part 1. p. 37. Lond. 1739.

more time and delay than the exigencies of ſtate will afford. The king of England is therefore not only the chief, but properly the ſole, magiſtrate of the nation; all others acting by commiſſion from, and in due ſubordination to, him: in like manner as, upon the great revolution in the Roman ſtate, all the powers of the ancient magiſtracy of the commonwealth were concentered in the new emperor; ſo that, as Gravina expreſſes it, *in ejus unius perſona veteris rei publicæ vis atque majeſtas per cumulatas magiſtratuum poteſtates exprimebatur.*

In the exertion of lawful prerogative the king is held to be abſolute; that is, ſo far abſolute, that there is no legal authority that can either delay or reſiſt him. He may reject what bills, may make what treaties, may coin what money, may create what peers, may pardon what offences, he pleaſes: unleſs where the conſtitution hath expreſsly, or by evident conſequence, laid down ſome exception or boundary; declaring, that thus far the prerogative ſhall go and no farther. For otherwiſe the power of the crown would indeed be but a name and a ſhadow, inſufficient for the ends of government, if, where its juriſdiction is clearly eſhabliſhed and allowed, any man or body of men were permitted to diſobey it, in the ordinary courſe of law: we do not now ſpeak of thoſe *extraordinary* recourſes to the firſt principles, which are neceſſary when the contracts of ſociety are in danger of diſſolution, and the law proves too weak a defence againſt the violence of fraud or oppreſſion. And yet the want of attending to this obvious diſtinction has occaſioned theſe doctrines, of abſolute power in the prince and of national reſiſtance by the people, to be much miſunderſtood and perverted, by the advocates for ſlavery on the one hand, and the demagogues of faction on the other. The former, obſerving the abſolute ſevereignty and tranſcendent dominion of the crown laid down (as it certainly is) moſt ſtrongly and emphatically in our law-books as well as our homilies, have denied that any caſe can be excepted from ſo general and poſitive a rule; forgetting how impoſſible it is, in any practical ſyſtem of laws, to point out beforehand thoſe eccentrical remedies, which the ſudden emergence of national diſtreſs may dictate, and which that alone can juſtify. On the other hand, over-zealous republicans, feeling the abſurdity of unlimited paſſive obedience, have fancifully (or ſometimes factiouſly) gone over to the other extreme: and, becauſe reſiſtance is juſtifiable to the perſon of the prince when the being of the ſtate is endangered, and the public voice proclaims ſuch reſiſtance neceſſary, they have therefore allowed to every individual the right of determining this expedience, and of employing private force to reſiſt even private oppreſſion. A doctrine productive of anarchy, and (in conſequence) equally fatal to civil liberty as tyranny itſelf. For civil liberty, rightly underſtood, conſiſts in protecting the rights of individuals by the united force of ſociety: ſociety cannot be maintained, and of courſe can exert no protection, without obedience to ſome ſovereign power; and obedience is an empty name, if every individual has a right to decide how far he himſelf ſhall obey.

In the exertion, therefore, of thoſe prerogatives which the law has given him, the king is irreſiſtible and abſolute, according to the forms of the conſtitution. And yet, if the conſequence of that exertion be manifeſtly to the grievance or diſhonour of the kingdom, the parliament will call his adviſers to a juſt and ſevere account. For prerogative conſiſting (as Mr Locke has well defined it) in the diſcretionary power of acting for the public good where the poſitive laws are ſilent, if that diſcretionary power be abuſed to the public detriment, ſuch prerogative is exerted in an unconſtitutional manner. Thus the king may make a treaty with a foreign ſtate, which ſhall irrevocably bind the nation; and yet, when ſuch treaties have been judged pernicious, impeachments have purſued thoſe miniſters by whoſe agency or advice they were concluded.

Prerogative.

The prerogatives of the crown (in the ſenſe under which we are now conſidering them) reſpect either this nation's intercourſe with foreign nations, or its own domeſtic government and civil polity.

With regard to *foreign concerns*, the king is the delegate or repreſentative of his people. It is impoſſible that the individuals of a ſtate, in their collective capacity, can tranſact the affairs of that ſtate with another community equally numerous as themſelves. Unanimity muſt be wanting to their meaſures, and ſtrength to the execution of their counſels. In the king therefore, as in a centre, all the rays of his people are united, and form by that union a conſiſtency, ſplendor, and power, that make him feared and reſpected by foreign potentates; who would ſcruple to enter into any engagement, that muſt afterwards be reviſed and ratified by a popular aſſembly. What is done by the royal authority, with regard to foreign powers, is the act of the whole nation: what is done without the king's concurrence, is the act only of private men. And ſo far is this point carried by our law, that it hath been held, that ſhould all the ſubjects of England make war with a king in league with the king of England, without the royal aſſent, ſuch war is no breach of the league. And, by the ſtatute 2 Hen. V. c. 6. any ſubject committing acts of hoſtility upon any nation in league with the king, was declared to be guilty of high treaſon: and, though that act was repealed by the ſtatute 20 Hen. VI. c. 11. ſo far as relates to the making this offence high treaſon, yet ſtill it remains a very great offence againſt the law of nations, and puniſhable by our laws, either capitally or otherwiſe, according to the circumſtances of the caſe.

1. The king therefore, conſidered as the repreſentative of his people, has the ſole power of ſending ambaſſadors to foreign ſtates, and receiving ambaſſadors at home.

2. It is alſo the king's prerogative to make treaties, leagues, and alliances, with foreign ſtates and princes. For it is, by the law of nations, eſſential to the goodneſs of a league, that it be made by the ſovereign power; and then it is binding upon the whole community: and in Britain the ſovereign power, *quoad hoc*, is veſted in the perſon of the king. Whatever contracts therefore he engages in, no other power in the kingdom can legally delay, reſiſt, or annul. And yet, leſt this plenitude of authority ſhould be abuſed to the detriment of the public, the conſtitution (as was hinted before) hath here interpoſed a check, by the means of parliamentary impeachment, for the puniſhment of ſuch miniſters as from criminal motives adviſe or conclude any treaty, which ſhall afterwards be judged to derogate from the honour and intereſt of the nation.

3. Upon the ſame principle the king has alſo the ſole prerogative of making war and peace. For it is

Prerogative.

held by all the writers on the law of nature and nations, that the right of making war, which by nature subsisted in every individual, is given up by all private persons that enter into society, and is vested in the sovereign power: and this right is given up, not only by individuals, but even by the entire body of people that are under the dominion of a sovereign. It would indeed be extremely improper, that any number of subjects should have the power of binding the supreme magistrate, and putting him against his will in a state of war. Whatever hostilities, therefore, may be committed by private citizens, the state ought not to be affected thereby; unless that should justify their proceedings, and thereby become partner in the guilt. And the reason which is given by Grotius, why, according to the law of nations, a denunciation of war ought always to precede the actual commencement of hostilities, is not so much that the enemy may be put upon his guard (which is matter rather of magnanimity than right), but that it may be certainly clear that the war is not undertaken by private persons, but by the will of the whole community; whose right of willing is in this case transferred to the supreme magistrate by the fundamental laws of society. So that, in order to make a war completely effectual, it is necessary with us in Britain that it be publicly declared and duly proclaimed by the king's authority; and then, all parts of both the contending nations, from the highest to the lowest, are bound by it. And wherever the right resides of beginning a national war, there also must reside the right of ending it, or the power of making peace. And the same check of parliamentary impeachment, for improper or inglorious conduct, in beginning, conducting, or concluding a national war, is in general sufficient to restrain the ministers of the crown from a wanton or injurious exertion of this great prerogative.

4. But, as the delay of making war may sometimes be detrimental to individuals who have suffered by depredations from foreign potentates, our laws have in some respects armed the subject with powers to impel the prerogative; by directing the ministers of the crown to issue letters of marque and reprisal upon due demand: the prerogative of granting which is nearly related to, and plainly derived from, that other of making war; this being indeed only an incomplete state of hostilities, and generally ending in a formal denunciation of war. These letters are grantable, by the law of nations, whenever the subjects of one state are oppressed and injured by those of another, and justice is denied by that state to which the oppressor belongs. In this case, letters of marque and reprisal (words in themselves synonymous, and signifying a taking in return) may be obtained, in order to seize the bodies or goods of the subjects of the offending state, until satisfaction be made, wherever they happen to be found. And indeed this custom of reprisals seems dictated by nature herself; for which reason we find in the most ancient times very notable instances of it. But here the necessity is obvious of calling in the sovereign power, to determine when reprisals may be made; else every private sufferer would be a judge in his own cause. In pursuance of which principle, it is with us declared by the statute 4 Hen. V. c. 7. that if any subjects of the realm are oppressed in time of truce by any foreigners, the king will grant marque in due form to all that feel themselves grieved. See Marque.

5. Upon exactly the same reason stands the prerogative of granting safe-conducts; without which, by the law of nations, no member of one society has a right to intrude into another. And therefore Puffendorf very justly resolves, that it is left in the power of all states to take such measures about the admission of strangers as they think convenient; those being ever excepted who are driven on the coasts by necessity, or by any cause that deserves pity or compassion. Great tenderness is shown by our laws, not only to foreigners in distress (see Wreck), but with regard also to the admission of strangers who come spontaneously: for so long as their nation continues at peace with ours, and they themselves behave peaceably, they are under the king's protection; though liable to be sent home whenever the king sees occasion. But no subject of a nation at war with us can, by the law of nations, come into the realm, nor can travel himself upon the high seas, or send his goods and merchandize from one place to another, without danger of being seized by our subjects, unless he has letters of safe-conduct; which, by divers ancient statutes, must be granted under the king's great seal and inrolled in chancery, or else they are of no effect; the king being supposed the best judge of such emergencies, as may deserve exception from the general law of arms. But passports under the king's sign-manual, or licences from his ambassadors abroad, are now more usually obtained, and are allowed to be of equal validity.

These are the principal prerogatives of the king respecting this nation's intercourse with foreign nations; in all of which he is considered as the delegate or representative of his people. But in domestic affairs, he is considered in a great variety of characters, and from thence there arises an abundant number of other prerogatives.

1. He is a constituent part of the supreme legislative power; and, as such, has the prerogative of rejecting such provisions in parliament as he judges improper to be passed. The expediency of which constitution has before been evinced at large under the article Parliament. We shall only farther remark, that the king is not bound by any act of parliament, unless he be named therein by special and particular words. The most general words that can be devised (any person or persons, bodies politic, or corporate, &c.) affect not him in the least, if they may tend to restrain or diminish any of his rights or interests. For it would be of most mischievous consequence to the public, if the strength of the executive power were liable to be curtailed, without its own express consent, by constructions and implications of the subject. Yet, where an act of parliament is expressly made for the preservation of public rights and the suppression of public wrongs, and does not interfere with the established rights of the crown, it is said to be binding as well upon the king as upon the subject: and, likewise, the king may take the benefit of any particular act, though he be not especially named.

2. The king is considered, in the next place, as the generalissimo, or the first in military command, within the kingdom. The great end of society is to protect the weakness of individuals by the united strength of the

the community; and the principal uſe of government is to direct that united ſtrength in the beſt and moſt effectual manner, to anſwer the end propoſed. Monarchical government is allowed to be the fitteſt of any for this purpoſe: it follows therefore, from the very end of its inſtitution, that in a monarchy the military power muſt be truſted in the hands of the prince.

In this capacity, therefore, of general of the kingdom, the king has the ſole power of raiſing and regulating fleets and armies. The manner in which they are raiſed and regulated is explained under the article *Military State*. We are now only to conſider the prerogative of enliſting and of governing them: which indeed was diſputed and claimed, contrary to all reaſon and precedent, by the long parliament of king Cha. I.; but, upon the reſtoration of his ſon, was ſolemnly declared by the ſtatute 13 Charles II. c. 6. to be in the king alone: for that the ſole ſupreme government and command of the militia within all his majeſty's realms and dominions, and of all forces by ſea and land, and of all forts and places of ſtrength, ever was and is the undoubted right of his majeſty, and his royal predeceſſors, kings and queens of England; and that both or either houſe of parliament cannot, nor ought to, pretend to the ſame.

This ſtatute, it is obvious to obſerve, extends not only to fleets and armies, but alſo to forts and other places of ſtrength within the realm; the ſole prerogative, as well of erecting, as manning and governing of which, belongs to the king in his capacity of general of the kingdom: and all lands were formerly ſubject to a tax, for building of caſtles wherever the king thought proper. This was one of the three things, from contributing to the performance of which no lands were exempted, and therefore called by the Anglo-Saxons the *trinoda neceſſitas; ſc. pontis reparatio, arcis conſtructio, et expeditio contra hoſtem.* And this they were called upon to do ſo often, that, as Sir Edward Coke from M. Paris aſſures us, there were in the time of Henry II. 1115 caſtles ſubſiſting in England. The inconveniencies of which, when granted out to private ſubjects, the lordly barons of thoſe times, were ſeverely felt by the whole kingdom; for, as William of Newburgh remarks in the reign of king Stephen, *erant in Anglia quodammodo tot reges, vel potius tyranni, quot domini caſtellorum;* but it was felt by none more ſenſibly than by two ſucceeding princes, king John and king Henry III. And therefore, the greateſt part of them being demoliſhed in the baron's wars, the kings of after times have been very cautious of ſuffering them to be rebuilt in a fortified manner: and Sir Edward Coke lays it down, that no ſubject can build a caſtle, or houſe of ſtrength imbattled, or other fortreſs defenſible, without the licence of the king; for the danger which might enſue, if every man at his pleaſure might do it.

It is partly upon the ſame, and partly upon a fiſcal foundation, to ſecure his marine revenue, that the king has the prerogative of appointing *ports* and *havens*, or ſuch places only, for perſons and merchandize to paſs into and out of the realm, as he in his wiſdom ſees proper. By the feodal law, all navigable rivers and havens were computed among the regalia, and were ſubject to the ſovereign of the ſtate. And in England it hath always been held, that the king is lord of the whole ſhore, and particularly is the guardian of the ports and havens, which are the inlets and gates of the realm: and therefore, ſo early as the reign of king John, we find ſhips ſeized by the king's officers for putting in at a place that was not a legal port. Theſe legal ports were undoubtedly at firſt aſſigned by the crown; ſince to each of them a court of portmote is incident, the juriſdiction of which muſt flow from the royal authority: the *great ports* of the ſea are alſo referred to, as well known and eſtabliſhed, by ſtatute 4 Hen. IV. c. 20. which prohibits the landing elſewhere under pain of confiſcation: and the ſtatute 1 Eliz. c. 11. recites, that the franchiſe of lading and diſcharging had been frequently granted by the crown.

But though the king had a power of granting the franchiſe of havens and ports, yet he had not the power of reſumption, or of narrowing and confining their limits when once eſtabliſhed; but any perſon had a right to load or diſcharge his merchandiſe in any part of the haven: whereby the revenue of the cuſtom was much impaired and diminiſhed, by fraudulent landings in obſcure and private corners. This occaſioned the ſtatutes of 1 Eliz. c. 11. and 13 and 14 Car. II. c. 11. § 14. which enable the crown by commiſſion, to aſcertain the limits of all ports, and to aſſign proper wharfs and quays in each port, for the excluſive landing and loading of merchandiſe.

The erection of beacons, light-houſes, and ſea-marks, is alſo a branch of the royal prerogative: whereof the firſt was anciently uſed in order to alarm the country, in caſe of the approach of an enemy; and all of them are ſignally uſeful in guiding and preſerving veſſels at ſea by night as well as by day. See BEACON.

3. Another capacity in which the king is conſidered in domeſtic affairs, is as the fountain of juſtice and general conſervator of the peace of the kingdom. See the article *Fountain of JUSTICE*.

4. The king is likewiſe the fountain of honour, of office, and of privilege: and this in a different ſenſe from that wherein he is ſtyled the *fountain of juſtice;* for here he is really the parent of them. See the articles *Fountain of JUSTICE* and *Fountain of HONOUR*.

5. Another light, in which the laws of England conſider the king with regard to domeſtic concerns, is as the arbiter of commerce. By commerce, we at preſent mean domeſtic commerce only; for the king's prerogative with regard to which, ſee *Regulation of WEIGHTS and Meaſures*, MONEY, &c.

6. The king is, laſtly, conſidered by the laws of England as the head and ſupreme governor of the national church.

To enter into the reaſons upon which this prerogative is founded is matter rather of divinity than of law. We ſhall therefore only obſerve, that by ſtatute 26 Hen. VIII. c. 1. (reciting that the king's majeſty juſtly and rightfully is and ought to be the ſupreme head of the church of England; and ſo had been recogniſed by the clergy of that kingdom in their convocation) it is enacted, that the king ſhall be reputed the only ſupreme head in earth of the church of England; and ſhall have, annexed to the imperial crown of this realm, as well the title and ſtyle thereof, as all juriſdictions, authorities, and commodities, to the ſaid dignity of ſupreme head of the church appertaining. And another ſtatute to the ſame purport was made, 1 Eliz. c. 1.

In virtue of this authority the king convenes, pro-

rogues, reſtrains, regulates, and diſſolves, all eccleſiaſtical ſynods or convocations. This was an inherent prerogative of the crown long before the time of Henry VIII. as appears by the ſtatute 8 Hen. VI. c. 1. and the many authors, both lawyers and hiſtorians, vouched by Sir Edward Coke. So that the ſtatute 25 Hen. VIII. c. 19. which reſtrains the convocation from making or putting in execution any canons repugnant to the king's prerogative, or the laws, cuſtoms, and ſtatutes of the realm, was merely declaratory of the old common law: that part of it only being new, which makes the king's royal aſſent actually neceſſary to the validity of every canon. The convocation or eccleſiaſtical ſynod, in England, differs conſiderably in its conſtitution from the ſynods of other Chriſtian kingdoms: thoſe conſiſting wholly of biſhops; whereas in England the convocation is the miniature of a parliament, wherein the archbiſhop preſides with regal ſtate; the upper houſe of biſhops repreſents the houſe of lords; and the lower houſe, compoſed of repreſentatives of the ſeveral dioceſes at large, and of each particular chapter therein, reſembles the houſe of commons with its knights of the ſhire and burgeſſes. This conſtitution is ſaid to be owing to the policy of Edward I. who thereby at one and the ſame time let in the inferior clergy to the privileges of forming eccleſiaſtical canons (which before they had not), and alſo introduced a method of taxing eccleſiaſtical benefices, by conſent of convocation.

From this prerogative alſo, of being the head of the church, ariſes the king's right of nomination to vacant biſhoprics, and certain other eccleſiaſtical preferments.

As head of the church, the king is likewiſe the *dernier reſort* in all eccleſiaſtical cauſes; an appeal lying ultimately to him in chancery from the ſentence of every eccleſiaſtical judge: which right was reſtored to the crown by ſtatute 25 Hen. VIII. c. 9.

III. The king's fiſcal prerogatives, or ſuch as regard his revenue. See the article Revenue.

Prerogative-Court, an Engliſh court eſtabliſhed for the trial of all teſtamentary cauſes, where the deceaſed hath left *bona notabilia* within two different dioceſes. In which caſe the probate of wills belongs to the archbiſhop of the province, by way of ſpecial prerogative. And all cauſes relating to the wills, adminiſtrations, or legacies of ſuch perſons, are originally cognizable herein, before a judge appointed by the archbiſhop, called the *judge of the prerogative-court;* from whom an appeal lies by ſtatute 25 Hen. VIII. c. 19. to the king in chancery, inſtead of the pope as formerly.

PRESAGE, in antiquity, denotes an augury, or ſign of ſome future event; which was chiefly taken from the flight of birds, the entrails of victims, &c. See Augury and Aruspices.

PRESBURG, the capital of the kingdom of Lower Hungary, called by the inhabitants *Poſony* and *Preſporen*, ſituated on the Danube, about 46 miles eaſt from Vienna, and 75 from Buda. The caſtle, in which the regalia are kept, ſtands on a hill above the town. Here the ſtates aſſemble; and in the cathedral, dedicated to St Martin, the king is crowned. The town is not very large, nor well built; but is very ancient, pleaſantly ſituated, and enjoys a good air. Its fortifications are only a double wall and ditch. In the lower ſuburbs is a hill, where the king, after his coronation, goes on horſeback, and brandiſhes St Stephen's ſword towards the four cardinal points, intimating, that he will defend his country againſt all its enemies. Beſides the cathedral, there are ſeveral other Popiſh and one Lutheran church, with a Jeſuits college, three convents, and two hoſpitals. It gives name to a county; and is the reſidence of the archbiſhop of Gran, who is primate, chief ſecretary, and chancellor of the kingdom, *legatus natus* of the Papal ſee, and prince of the holy Roman empire. E. Long. 17. 30. N. Lat. 48. 20.

PRESBYTÆ, perſons whoſe eyes are too flat to refract the rays ſufficiently, ſo that unleſs the object is at ſome diſtance, the rays coming from it will paſs through the retina before their union, conſequently viſion is confuſed; old people are uſually the ſubjects of this diſeaſe. In order to remedy, or at leaſt to palliate, this defect, the perſon ſhould firſt uſe glaſſes which do not magnify, and from them paſs gradually to more convex ſpectacles, which ſhorten the focus.

PRESBYTER, in the primitive Chriſtian church, an elder, one of the ſecond order of eccleſiaſtics; the other two being biſhops and deacons. See the articles Bishop and Deacon.

Preſbyter or elder is a word borrowed from the Greek tranſlation of the Old Teſtament, where it commonly ſignifies ruler or governor; it being a note of office and dignity, not of age; and in this ſenſe biſhops are ſometimes called *preſbyters* in the New Teſtament. The preſbyters might baptize, preach, conſecrate, and adminiſter the euchariſt in the biſhop's abſence, or in his preſence if he authoriſed and deputed them; and the biſhops did ſcarce any thing in the government of the church without their advice, conſent, and amicable concurrence.

The grand diſpute between the followers of the Geneva and Roman diſcipline, is about the ſameneſs and difference of preſbyters and biſhops at the time of the apoſtles. See Episcopacy, Independents, and the following article.

1 Diſcriminating principles of the Preſbyterians

PRESBYTERIANS, Proteſtants, ſo called from their maintaining that the government of the church appointed in the New Teſtament was by preſbyteries, that is, by aſſociations of miniſters and ruling elders, poſſeſſed all of equal powers, without any ſuperiority among them either in office or in order.

The Preſbyterians believe, thatthe authority of their miniſters to preach the goſpel, to adminiſter the ſacraments of baptiſm and the Lord's ſupper, and to feed the flock of Chriſt, is derived from the Holy Ghoſt by the impoſition of the hands of the preſbytery; and they oppoſe the independent ſcheme of the common rights of Chriſtians by the ſame arguments which are uſed for that purpoſe by the Epiſcopalians (ſee Episcopacy). They affirm, however, that there is no order in the church as eſtabliſhed by Chriſt and his apoſtles ſuperior to that of preſbyters; that all miniſters being ambaſſadors of Chriſt, are equal by their commiſſion; that *preſbyter* and *biſhop*, though different words, are of the ſame import; and that prelacy was gradually eſtabliſhed upon the primitive practice of making the *moderator* or ſpeaker of the preſbytery a permanent officer.

2 Scriptural arguments againſt epiſcopacy

Theſe poſitions they maintain againſt the Epiſcopalians by the following ſcriptural arguments. They obſerve, that the apoſtles planted churches by ordaining biſhops and deacons in every city; that the miniſters which in one verſe are called biſhops are in the next

perhaps

[...]byte-
[...]ans.

perhaps denominated preſbyters; that we nowhere read in the New Teſtament of biſhops, preſbyters, and deacons, in any one church; and that therefore we are under the neceſſity of concluding *biſhop* and *preſbyter* to be two names for the ſame church officer. This is apparent from Peter's exhortation to the *elders* or *preſbyters* who were among the Jewiſh Chriſtians. "The *elders* (preſbyters) which are among you I exhort, who am alſo an *elder*, and a witneſs of the ſufferings of Chriſt, and alſo a partaker of the glory that ſhall be revealed: Feed the flock of God which is among you, taking the *overſight* thereof (επισκοπουντες acting as *biſhops* thereof), not by conſtraint, but willingly; not for filthy lucre, but of a ready mind; neither as being LORDS over God's heritage, but being enſamples to the flock*." From this paſſage it is evident, that the preſbyters not only fed the flock of God, but alſo governed that flock with epiſcopal powers; and that the apoſtle himſelf, as a church officer, was nothing more than a preſbyter or elder. The identity of the office of biſhop and preſbyter is ſtill more apparent from Heb. xiii. 7. 17. and 1 Theſſ. v. 12.; for the biſhops are there repreſented as governing the flock, ſpeaking to them the word of God, watching for their ſouls, and diſcharging various offices, which it is impoſſible for any man to perform to more than one congregation.

* [1] Peter [v. 1], 2, 3.

3
[Rea]ſons for [ſup]poſing [biſh]ops and [pre]ſbyters [t]he ſame [offic]er.

From the laſt cited text it is evident, that the biſhops (προισταμενους) of the Theſſalonian churches had the paſtoral care of no more ſouls than they could hold perſonal communion with in God's worſhip; for they were ſuch as all the people were to *know*, *eſteem*, and *love*, as thoſe that not only were *over them*, but alſo "cloſely laboured among them and admoniſhed them." But dioceſan biſhops, whom ordinarily the hundredth part of their flock never hear nor ſee, cannot be thoſe biſhops by whom that flock is admoniſhed, nor can they be what Peter requires the biſhops of the Jewiſh converts to be *enſamples to the flock*. It is the opinion of Dr Hammond, who was a very learned divine, and a zealot for epiſcopacy, that the *elders* whom the apoſtle James deſires† the ſick to call for, were of the higheſt permanent order of eccleſiaſtical officers; but it is ſelf-evident that thoſe elders cannot have been dioceſan biſhops, otherwiſe the ſick muſt have been often without the reach of the remedy propoſed to them.

† Chap. v.

There is nothing in Scripture upon which the Epiſcopalian is more ready to reſt his cauſe than the alleged epiſcopacy of Timothy and Titus; of whom the former is ſaid to have been biſhop of Epheſus, and the latter biſhop of Crete; yet the Preſbyterian thinks it as clear as the noon-day ſun, that the preſbyters of Epheſus were ſupreme governors under Chriſt of the Epheſian churches, at the very time that Timothy is pretended to have been their proper dioceſan.

In Acts xx. 17, &c. we read, that "from Miletus Paul ſent to Epheſus, and called the elders (preſbyters) of the church. And when they were come to him, he ſaid unto them, Ye know, from the firſt day that I came into Aſia, after what manner I have been with you, at all ſeaſons. And now I know that ye all, among whom I have gone preaching the kingdom of God, ſhall ſee my face no more. Wherefore I take you to record this day, that I am pure from the blood of all men. For I have not ſhunned to declare unto you all the counſel of God. Take heed therefore unto yourſelves, and to all the flock over which the Holy Ghoſt hath made you overſeers (επισκοπους *biſhops*), to feed the church of God, which he hath purchaſed with his own blood. For I know this, that after my departure ſhall grievous wolves enter in among you, not ſparing the flock. Alſo of your ownſelves ſhall men ariſe, ſpeaking perverſe things, to draw away diſciples after them. Therefore watch, and remember, that by the ſpace of three years, I ceaſed not to warn every one night and day with tears. And now, brethren, I recommend you to God, and to the word of his grace," &c.

Preſbyterians.

4
The paſtors of Epheſus of equal authority.

From this paſſage, it is evident that there was in the city of Epheſus a plurality of paſtors of equal authority without any ſuperior paſtor or biſhop over them; for the apoſtle directs his diſcourſe to them all in common, and gives them equal power over the whole flock. Dr Hammond indeed imagines, that the elders whom Paul called to Miletus were the *biſhops* of *Aſia*, and that he ſent for them to Epheſus, becauſe that city was the metropolis of the province. But were this opinion well-founded, it is not conceivable that the ſacred writer would have called them the elders of the church of *Epheſus*, but the elders of the *church in general*, or the elders of the *churches in Aſia*. Beſides, it is to be remembered, that the apoſtle was in ſuch haſte to be at Jeruſalem, that the ſacred hiſtorian meaſures his time by *days*; whereas it muſt have required ſeveral months to call together the biſhops or elders of all the cities of Aſia; and he might certainly have gone to meet them at Epheſus in leſs time than would be requiſite for their meeting in that city and proceeding thence to him at Miletus. They muſt therefore have been either the joint paſtors of one congregation, or the paſtors of different congregations in one city: and as it was thus in Epheſus, ſo was it in Philippi; for we find the apoſtle addreſſing his epiſtle "to all the ſaints in Chriſt Jeſus which are at Philippi, with the biſhops and deacons." From the paſſage before us it is likewiſe plain, that the preſbyters of Epheſus had not only the *name* but the whole *power* of biſhops given to them by the Holy Ghoſt; for they are enjoined to do the whole work of biſhops—ποιμαινειν την εκκλησιαν του θεου—which ſignifies, to *rule* as well as *feed* the church of God. Whence we ſee, that the apoſtle makes the power of *governing* inſeparable from that of *preaching* and *watching*; and that according to him, all who are preachers of God's word, and watchmen of ſouls, are neceſſarily rulers or governors of the church, without being accountable for their management to any prelate, but only to their Lord Chriſt from whom their power is derived.

5
Timothy no biſhop.

It appears therefore, that the apoſtle Paul left in the church of Epheſus, which he had planted, no other ſucceſſors to himſelf than *preſbyter-biſhops* or Preſbyterian miniſters, and that he did not devolve his power upon any prelate. Timothy, whom the Epiſcopalians allege to have been the firſt biſhop of Epheſus, was preſent when this ſettlement was made*; and it is ſurely not to be ſuppoſed, that, had he been their biſhop, the apoſtle would have devolved the whole epiſcopal power upon the preſbyters before his face. If ever there was a ſeaſon fitter than another for pointing out the duty of this ſuppoſed biſhop to his dioceſe, and his preſbyters duty to him, it was ſurely when Paul was taking his final leave of them, and diſcourſing ſo pathetically con-

* Acts xx. 5.

Presbyterians

cerning the duty of *overseers*, the coming of ravenous wolves, and the consequent hazard of the flock. In this farewel discourse, he tells them that "he had not shunned to declare unto them all the counsel of God." But with what truth could this have been said, if obedience to a diocesan bishop had been any part of their duty either at the time of the apostle's speaking or at any future period? He foresaw that ravenous wolves would enter in among them, and that even some of themselves should arise speaking perverse things; and if, as the Episcopalians allege, diocesan episcopacy was the remedy provided for those evils, is it not strange, passing strange, that the inspired preacher did not foresee that Timothy, who was standing beside him, was destined to fill that important office; or if he did foresee it, that he omitted to recommend him to his future charge, and to give him proper instructions for the discharge of his duty?

6 But an evangelist.

But if Timothy was not bishop of Ephesus, what, it may be asked, was his office in that city? for that he resided there for some time, and was by the apostle invested with authority to ordain and rebuke presbyters, are facts about which all parties are agreed, and which indeed cannot be controverted by any reader of Paul's epistles. To this the Presbyterian replies with confidence, that the power which Timothy exercised in the church of Ephesus was that of an evangelist †, and not a fixed prelate. But, according to Eusebius, the work of an evangelist was, "to lay the foundations of the faith in barbarous nations, and to constitute among them pastors; after which he passed on to other countries." Accordingly we find, that Timothy was resident for a time at Philippi and Corinth ‡ as well as at Ephesus, and that he had as much authority over those churches as over that of which he is said to have been the fixed bishop. "Now, if Timotheus come, see that he may be with you without fear, for he worketh the work of the Lord, as I also do. Let no man therefore despise him." This text might lead us to suppose, that Timothy was bishop of Corinth as well as of Ephesus; for it is stronger than that upon which his episcopacy of the latter church is chiefly built. The apostle says, "I besought thee* to abide still at Ephesus, when I went into Macedonia, that thou mightest charge some that they teach no other doctrine." But had Timothy been the fixed bishop of that city, there would surely have been no necessity for *beseeching* him to abide with his flock. It is to be observed, too, that the first epistle to Timothy, which alone was written to him during his residence at Ephesus, was of a date prior to Paul's meeting with the elders of that church at Miletus; for in the epistle he hopes to come to him shortly, whereas he tells the elders at Miletus that they should see his face no more. This being the case, it is evident that Timothy was left by the apostle at Ephesus only to supply his place during his temporary absence at Macedonia, and that he could not possibly have been constituted fixed bishop of that church, since the episcopal powers were afterwards committed to the presbyters by the Holy Ghost in his presence.

† 2 Tim. 4, 5.

‡ Phil. ii. 19. 1 Cor. iv. 17. xvi. 10, 11.

* 1 Tim. i. 3.

7 Presbyterate the highest permanent office in the church.

The identity of the office of bishop and presbyter being thus clearly established, it follows, that the presbyterate is the highest permanent office in the church, and that every faithful pastor of a flock is successor to the apostles in every thing in which they were to have any successors. In the apostolic office there were indeed some things peculiar and extraordinary, such as their immediate call by Christ, their infallibility, their being witnesses of our Lord's resurrection, and their unlimited jurisdiction over the whole world. These powers and privileges could not be conveyed by imposition of hands to any successors, whether called presbyters or bishops; but as rulers or office-bearers in particular churches, we have the confession of "the very chiefest apostles," Peter and John, that they were nothing more than presbyters or parish ministers. This being the case, the dispute, which in the early part of the passing century was so warmly agitated concerning the validity of Presbyterian ordination, may be soon decided; for if the ceremony of ordination be at all essential, it is obvious that such a ceremony performed by presbyters must be valid, as there is no higher order of ecclesiastics in the church by whom it can be performed. Accordingly we find, that Timothy himself, though said to be a bishop, was ordained by the laying on of the hands of a presbytery. At that ordination indeed St Paul presided, but he could preside only as *primus in paribus;* for we have seen that, as permanent officers in the church of Christ, the apostles themselves were no more than presbyters. If the apostles hands were imposed for any other purpose, it must have been to communicate those *charismata* or miraculous gifts of the Holy Spirit, which were then so frequent; but which no modern presbyter or bishop will pretend to give, unless his understanding be clouded by the grossest ignorance, or perverted by the most frantic enthusiasm.

8 Rise of episcopacy.

But if the office of bishop and presbyter was originally the same, how, it will be asked, came diocesan episcopacy to prevail so universally as it is confessed to have done before the conversion of Constantine and the civil establishment of Christianity in the Roman empire? To give a satisfactory answer to this question is certainly the most arduous task which the advocate for presbytery has to perform; but it is a task not insurmountable.

From many passages in the New Testament *, it is evident, that when the apostles planted churches in different cities, they generally settled more than one pastor in the same church, to feed and govern it with joint authority. The propriety of this constitution is obvious. In those days, when the disciples of Christ were persecuted for their religion, and often obliged to meet in the "night for fear of the Jews," they could not with any degree of prudence assemble in large numbers; and therefore, had there been no more than one pastor in a city, the Christian converts, though, when assembled, they might have amounted to but a small congregation, could not all have enjoyed the benefit of public worship on the same day; at least it is obvious that they could not possibly have assembled for this purpose so often as their want of instruction, and the duty of "breaking of bread and of prayer," required them to meet. It was therefore with great wisdom that the apostles ordained several presbyters in the same church; but as these presbyters would have occasion to meet frequently, and to deliberate on the state of the flock which it was their duty to feed, and over which they had all equal authority, they would be under the necessity of electing one of their own number

* Acts xi. 29. xiii. 1, 2, 3. xv. Tit. i. 5.

Preſbyterians.

number to be preſident or *moderator* of the preſbytery, that order might be preſerved, and all things done with decency. At firſt there is reaſon to believe that thoſe preſidents held their office no longer than while the preſbyteries ſat in which they were elected. Among the apoſtles themſelves there was no fixed preſident. Peter indeed appears to have been moſt frequently admitted to that honour; but there is one very memorable occaſion on record †, when James the Lord's brother preſided in an aſſembly of apoſtles, elders, and brethren, held at Jeruſalem, to determine the queſtion concerning the neceſſity of circumciſing the Gentiles, and commanding them to keep the law of Moſes.

† Acts xv.

Upon this model were the primitive preſbyteries formed. They conſiſted of ſeveral preſbyters poſſeſſed of equal powers, who at their meetings appointed one of their own number to diſcharge the office of moderator or temporary preſident; but to this preſident they gave no prelatical powers or negative voice over the

9
According to Jerome.

deliberations of his brethren; for, as Jerome informs us, the church was then governed *communi preſbyterorum concilio*, "by a common council of preſbyters." It appears, however, that when an apoſtle, an apoſtolical man, or an evangeliſt, fixed his reſidence in any city, and took upon himſelf the paſtoral care of part of the flock, his co-preſbyters, from reſpect to his ſingular gifts, made him their conſtant and fixed moderator. Hence Timothy, during his abode at Epheſus, was moderator of the preſbytery; and hence too Mark the evangeliſt, who reſided many years in Alexandria, has been called the firſt biſhop of that church, though he appears to have been nothing more than permanent moderator. We advance this upon the authority of Jerome, one of the moſt learned fathers of the Chriſtian church, who informs us, that upon the death of the evangeliſt, the preſbyters of Alexandria, for more than 200 years, choſe their biſhops from their own number, and placed them in the epiſcopal chair, without dreaming that they ought to be raiſed to a higher order by a new conſecration;—*Preſbyteri unum ex ſe electum in excelſiori gradu collocatum, epiſcopum nominabant.* As this practice of making the moderator of the preſbytery of Alexandria a permanent officer, was thought a good expedient to guard the infant churches againſt ſchiſms and diviſions, thoſe churches gradually adopted it. For, as Jerome tells us, *Poſtquam unuſquiſque eos quos baptizaverat, ſuos putabat eſſe, non Chriſti, in toto orbe decretum eſt, ut unus de preſbyteris electus, ſuperponeretur cæteris, ad quem omnis eccleſiæ cura pertineret, et ſchiſmatum ſemina tollerentur.*

The advantages which, in diſplaying his talents and authority, the perpetual preſident or ſpeaker of any aſſembly has over his colleagues in office, are ſo obvious, that when the practice of electing their moderators for life became univerſal among the preſbyteries of the primitive church, it is eaſy to conceive how ambitious men might ſo magnify the difficulties and importance of their ſtation, as to introduce the cuſtom of filling it by a new conſecration of the biſhop elect. But when this was done, dioceſan epiſcopacy, with all its powers and prerogatives, would follow as a thing of courſe, until "by little and little (as Jerome expreſſes himſelf) the whole paſtoral care of the flock was devolved upon one man."

Our limits will not permit us to trace more minutely the riſe and progreſs of this eccleſiaſtical uſurpation, as the Preſbyterian calls it; but the reader who wiſhes for fuller information, after ſtudying the remains of the four firſt centuries of the Chriſtian church, may conſult *An Inquiry into the Conſtitution, Diſcipline, and Worſhip, of the Primitive Church*, ſaid to have been written by Sir Peter King, afterwards lord chancellor of England. As an impartial lover of truth, he will do well to conſult alſo a book intitled *An original Draught of the Primitive Church*, which was publiſhed as an anſwer to the Inquiry; and he may read with much advantage to himſelf *A Letter from a parochial biſhop to a prelatical gentleman*, with *An Apology for the church of Scotland*, both written by Mr Williſon ſome time miniſter in Dundee, and both evincing conſiderable learning and great ingenuity in their pious author.

10
The church of Scotland.

Of the churches at preſent formed upon this model, we believe, that without incurring the imputation of national prejudice, we may ſafely affirm the church of Scotland to be by much the moſt reſpectable. Her mode of worſhip is ſimple and ſolemn; her eſtabliſhed faith agreeable to the confeſſions of moſt other Proteſtant churches; her judicatories are calculated to maintain the rights of the people; and her paſtors are confeſſedly men of liberal and enlightened minds. On theſe accounts it appears to us, that we cannot more properly conclude this article than with a ſhort view of her conſtitution, as being that in which our Preſbyterian readers are undoubtedly moſt intereſted.

No one is ignorant, that from the firſt dawn of reformation among us, till the era of the revolution, there was a perpetual ſtruggle between the court and the people for the eſtabliſhment of an Epiſcopal or a Preſbyterian form of church government: The former model of eccleſiaſtical polity was patroniſed by the houſe of Stuart on account of the ſupport which it gave to the prerogatives of the crown; the latter was the favourite of the majority of the people, perhaps not ſo much on account of its ſuperior claim to apoſtolical inſtitution, as becauſe the laity are mixed with the clergy in church judicatories, and the two orders, which under epiſcopacy are kept ſo diſtinct, incorporated, as it were, into one body. In the Scottiſh church, every regulation of public worſhip, every act of diſcipline, and every eccleſiaſtical cenſure, which in other churches flows from the authority of a dioceſan biſhop, or from a convocation of the clergy, is the joint work of a certain number of clergymen and laymen acting together with equal authority, and deciding every queſtion by a plurality of voices.

11
Governed by clergymen and laymen.

The laymen who thus form an eſſential part of the eccleſiaſtical courts of Scotland, are called *ruling elders*; and hold the ſame office, as well as the ſame name, with thoſe brethren * who joined with the apoſtles and elders at Jeruſalem in determining the important queſtion concerning the neceſſity of impoſing upon the Gentile converts the ritual obſervances of the law of Moſes. Theſe lay-elders Paul enjoined Timothy § to account worthy of double honour, if they ſhould rule well, and diſcharge the duties for which they were ſeparated from the multitude of their brethren. In the church of Scotland every pariſh has two or three of thoſe lay-elders, who are grave and ſerious perſons choſen from among the heads of families, of known orthodoxy and ſteady adherence to the worſhip, diſcipline, and government of the church. Being

* Acts xv.

§ 1 Tim. v. 17.

Presbyterians.

ing solemnly engaged to use their utmost endeavours for the suppression of vice and the cherishing of piety and virtue, and to exercise discipline faithfully and diligently, the minister, in the presence of the congregation, sets them apart to their office by solemn prayer; and concludes the ceremony, which is sometimes called ordination, with exhorting both elders and people to their respective duties.

12 The kirk-session.

The kirk-session, which is the lowest ecclesiastical judicatory, consists of the minister and those elders of the congregation. The minister is *ex officio* moderator, but has no negative voice over the decision of the session; nor indeed has he a right to vote at all, unless when the voices of the elders are equal and opposite. He may indeed enter his protest against their sentence, if he think it improper, and appeal to the judgment of the presbytery; but this privilege belongs equally to every elder, as well as to every person who may believe himself aggrieved by the proceedings of the session. The deacons, whose proper office it is to take care of the poor, may be present in every session, and offer their counsel on all questions that come before it; but except in what relates to the distribution of alms, they have no decisive vote with the minister and elders.

13 The presbytery.

The next judicatory is the *presbytery*, which consists of all the pastors within a certain district, and one ruling elder from each parish commissioned by his brethren to represent, in conjunction with the minister, the session of that parish. The presbytery treats of such matters as concern the particular churches within its limits; as the examination, admission, ordination, and censuring of ministers; the licensing of probationers, rebuking of gross or contumacious sinners, the directing of the sentence of excommunication, the deciding upon references and appeals from kirk-sessions, resolving cases of conscience, explaining difficulties in doctrine or discipline; and censuring, according to the word of God, any heresy or erroneous doctrine which hath been either publicly or privately maintained within the bounds of its jurisdiction. Partial as we may be thought to our own church, we frankly acknowledge that we cannot altogether approve of that part of her constitution which gives an equal vote, in questions of heresy, to an illiterate mechanic and his enlightened pastor. We are persuaded that it has been the source of much trouble to many a pious clergyman; who, from the laudable desire of explaining the scriptures and declaring to his flock all the counsel of God, has employed a variety of expressions of the same import, to illustrate those articles of faith, which may be obscurely expressed in the established standards. The fact however is, that, in presbyteries, the only prerogatives which the pastors have over the ruling elders, are the power of ordination by imposition of hands, and the privilege of having the moderator chosen from their body.

14 The provincial synod.

From the judgment of the presbytery there lies an appeal to the provincial synod, which ordinarily meets twice in the year, and exercises over the presbyteries within the province a jurisdiction similar to that which is vested in each presbytery over the several kirk-sessions within its bounds. Of these synods there are in the church of Scotland fifteen, which are composed of the members of the several presbyteries within the respective provinces which give names to the synods.

15 The general assembly.

The highest authority in the church of Scotland is the general assembly, which consists of a certain number of ministers and ruling elders delegated from each presbytery, and of commissioners from the universities and royal boroughs. A presbytery in which there are fewer than twelve parishes, sends to the general assembly two ministers and one ruling elder: if it contain between 12 and 18 ministers, it sends three of these, and one ruling elder: if it contain between 18 and 24 ministers, it sends four ministers and two ruling elders; and of 24 ministers, when it contains so many, it sends five with two ruling elders. Every royal borough sends one ruling elder, and Edinburgh two; whose election must be attested by the kirk-sessions of their respective boroughs. Every university sends one commissioner from its own body. The commissioners are chosen annually six weeks before the meeting of the assembly; and the ruling elders are often men of the first eminence in the kingdom for rank and talents. In this assembly, which meets once a year, the king presides by his commissioner, who is always a nobleman; but he has no voice in their deliberations. The order of their proceedings is regular, though sometimes the number of members creates a confusion, which the moderator, who is chosen from among the ministers to be, as it were, the speaker of the house, has not sufficient authority to prevent. Appeals are brought from all the other ecclesiastical courts in Scotland to the general assembly; and in questions purely religious no appeal lies from its determinations. —In the subordination of these assemblies, parochial, presbyterial, provincial, and national, the less unto the greater, consists the external order, strength, and stedfastness of the church of Scotland.

PRESCIENCE, in theology, prevision, or foreknowledge; that knowledge which God has of things to come.—The doctrine of predestination is founded on the prescience of God, and on the supposition of all futurity's being present to him. See PREDESTINATION.

PRESCRIPTION, in medicine, is the assigning a proper and adequate remedy to the disease, from an examination of its symptoms, and an acquaintance with the virtues and effects of the materia medica.

PRESCRIPTION, in law, is a title acquired by use and time, and allowed by law; as when a man claims any thing, because he, his ancestors, or they whose estate he hath, have had or used it all the time whereof no memory is to the contrary: or it is where for continuance of time, *ultra memoriam hominis*, a particular person hath a particular right against another.

There is a difference between prescription, custom, and usage. *Prescription* hath respect to a certain person, who *by intendment* may have continuance *for ever;* as for instance, he and all they *whose estate he hath* in such a thing, this is a prescription: but, *Custom* is *local*, and always applied to a *certain* place; as, *time out of mind there has been such a custom in such a place*, &c. And *prescription* belongeth to *one* or a *few* only; but *custom* is common to *all*. *Usage* differs from both, for it may be either to *persons* or *places;* as to *inhabitants of a town to have a way*, &c.

A custom and prescription are in the *right;* usage is in the *possession;* and a prescription that is good for the matter and substance, may be bad by the manner of setting it forth: but where that which is claimed *as a custom*, in or for many, will be good, *that* regularly will be so when claimed by *prescription* for one. *Prescription* is to be

be *time out of mind;* though it is not the length of time that begets the right of prescription, nothing being done by time, although every thing is done in time; *but it is a presumption in law, that a thing cannot continue so long quiet, if it was against right, or injurious to another.*

PRESCRIPTION, in Scotch law. See LAW, p. 698, and 725.

PRESCRIPTION, in theology, was a kind of argument pleaded by Tertullian and others in the 3d century against erroneous doctors. This mode of arguing has been despised by some, both because it has been used by Papists, and because they think that truth has no need of such a support. But surely in disputed points, if it can be shown that any particular doctrine of Christianity was held in the earliest ages, even approaching the apostolic, it must have very considerable weight; and indeed that it has so, appears from the universal appeals of all parties to those early times in support of their particular opinions. Besides, the thing is in itself natural; for if a man finds a variety of opinions in the world upon important passages in scripture, where shall he be so apt to get the true sense as from cotemporary writers or others who lived very near the apostolic age? and if such a man shall find any doctrine or interpretation to have been universally believed in the first ages, or as Vincentius Lirinensis words it, *semper ubique et ab omnibus*, he will unquestionably be disposed to think such early and universal consent, or such prescription, of very considerable weight in determining his opinion.

PRESENCE, a term of relation, used in opposition to absence, and signifying the existence of a person in a certain place.

PRESENT *Tense*, in grammar, the first tense of a verb, expressing the present time, or that something is now performing; as *scribo*, I write, or am writing. See GRAMMAR.

PRESENTATION, in ecclesiastical law. See PATRONAGE.

PRESENTATION *of the Virgin*, is a feast of the Romish church, celebrated on the 21st of November, in memory of the Holy Virgin's being presented by her parents in the temple, to be there educated. Emanuel Comnenus, who began to reign in 1143, makes mention of this feast in his Constitution. Some imagine it to have been established among the Greeks in the 11th century; and think they see evident proofs of it in some homilies of George of Nicomedia, who lived in the time of Photius. Its institution in the West is ascribed to Gregory XI. in 1372. Some think it was instituted in memory of the ceremony practised among the Jews for their new-born females; corresponding to the circumcision on the eighth day for males.

PRESENTATION *of our Lady* also gives the title to three orders of nuns. The first, projected in 1618, by a maid named Joan of Cambray. The habit of the nuns, according to the vision she pretended to have, was to be a grey gown of natural wool, &c.; but this project was never accomplished. The second was established in France, about the year 1627, by Nicholas Sanguin, bishop of Senlis; it was approved by Urban VIII. This order never made any great progress. The third was established in 1664, when Frederic Borromeo, being apostolical visitor in the Valteline, was intreated by some devout maids at Morbegno to allow them to live in community in a retired place; which he granted, and erected them into a congregation, under the title of *congregation of our Lady*. They live under the rule of St Augustine.

PRESENTMENT, in law. See PROSECUTION.

A presentment, generally taken, is a very comprehensive term; including not only *presentments* properly so called, but also inquisitions of office, and indictments by a grand jury. A presentment, properly speaking, is the notice taken by a grand jury of any offence from their own knowledge or observation, without any bill of indictment laid before them at the suit of the king: As the presentment of a nuisance, a libel, and the like; upon which the officer of the court must afterwards frame an indictment, before the party presented can be put to answer it. An inquisition of office is the act of a jury, summoned by the proper officer to inquire of matters relating to the crown, upon evidence laid before them. Some of these are in themselves convictions, and cannot afterwards be traversed or denied; and therefore the inquest, or jury, ought to hear all that can be alleged on both sides. Of this nature are all inquisitions of *felo de se;* of flight in persons accused of felony; of deodands, and the like; and presentments of petty offences in the sheriff's tourn or court-leet, whereupon the presiding officer may set a fine. Other inquisitions may be afterwards traversed and examined; as particularly the coroner's inquisition of the death of a man, when it finds any one guilty of homicide; for in such cases the offender so presented must be arraigned upon this inquisition, and may dispute the truth of it; which brings it to a kind of indictment, the most usual and effectual means of prosecution. See INDICTMENT.

PRESIDENT, PRÆSES, is an officer created or elected to preside over a company or assembly; so called in contradistinction to the other members, who are termed *residents*.

Lord PRESIDENT *of the Council*, is a great officer of the crown, who has precedence next after the lord chancellor and lord treasurer; as ancient as the time of King John, when he was styled *consiliarius capitalis.*—His office is to attend on the king, to propose business at the council-table, and to report to the king the several transactions there. See *Privy-Council.*

PRESIDIAL, was a tribunal, or bench of judges, established (before the Revolution) in the several considerable cities of France, to judge ultimately, or in the last resort, of the several causes brought before them by way of appeal from the subaltern judges. The presidials made one company with the officers of the bailliages and seneschaussees, where they were established.

PRESS (PRELUM), in the mechanic arts, a machine made of iron or wood, serving to squeeze or compress any body very close.

The ordinary presses consist of six members, or pieces; viz. two flat smooth planks; between which the things to be pressed are laid; two screws, or worms, fastened to the lower plank, and passing through two holes in the upper; and two nuts, in form of an S, serving to drive the upper plank, which is moveable, against the lower, which is stable, and without motion.

PRESSES *used for expressing of Liquors*, are of various kinds; some, in most respects, the same with the common presses, excepting that the under plank is per-

 forated

Press. forated with a great number of holes, to let the juice expressed run through into a tub, or receiver, underneath.

A very useful machine for a press, in the process of cyder-making, has been lately constructed by Mr Anstice, who, with his well-known zeal for the improvement of mechanics, permits us to lay before our readers the following description of it.

Plate CCCCXV. AA, n°1. two pieces of timber, 21 feet long, 12 by 6 inches, laid side by side at the distance of 12 inches, and secured in that situation by blocks placed between and bolts passing through them; this frame forms the bed of the machine. BB, two uprights, 12 feet long, 6 by 8 inches, morticed upon them, and secured in their position by pins and iron squares. CC, two uprights, five feet long, six by 10 inches, morticed near the end of the under frame, and secured as before. D, a lever, 17 feet long, 12 by 13 inches, turning on a large bolt which passes through the short uprights, also through iron straps, which secure them to the bed inside, and a stirrup of iron which passes over the end of the lever, and which makes the turning point in the line of its lower side, and not through its middle. E, a lever 20 feet long, six by eight inches at its largest part, and tapering towards the other end: this lever turns on a bolt in the uprights BB. F, 1, 2, 3, 4. four pieces of oak (which he calls *needles*, 10 feet long), four by two and an half inches, morticed loosely into the upper lever, and hung thereto by bolts, so as to swing perpendicularly, and play in a long mortice or channel cut through the large lever to receive them. These needles have inch-holes pretty closely bored through them (in a direction crossing the machine), from the lower ends, as far upwards as the great lever will reach, when it is as high as it can go. G, a bed to receive what is to be pressed. H, a frame to support a winch worked by a handle at I. At the end of the small lever two blocks or pulleys are fixed, one above, and the other below it; a rope of about half an inch diameter is then fastened to the cieling (or continuation of the uprights of the winch frame if necessary) at K; then passed through the upper block on the lever, from thence passed through a block at L, and then goes with four turns round the winch, from whence it is carried through the block under the lever, and fastens to the machine at M; by this means, if the winch be turned one way, it raises the end of the small lever if the other depresses it.

To work the machine. If we suppose the great lever bearing on the matter to be pressed, an iron pin must be put into one of the holes in the needles above the great lever; and when the small lever is worked as far as it will go, either up or down, another bolt is to be put into the hole, which comes nearest above the great lever on the other side of the uprights BB, and the winch then turned the contrary way, by which means the pressing goes on whether the small lever rises or falls. Before the resistance is very great, the needles farthest from the fulcrum of the small lever are used; after that the nearest are employed, which doubles the power of the machine. In raising the great lever, or lowering it to its bearing, the needles most distant from the fulcrum of the small lever, are used *under* instead of *over* it. As the rope is liable to stretch and get slack, he passes it, after taking two turns on the winch, through a pulley, to which is suspended a weight of half a hundred, and then takes two turns more before it is carried through the other block, by which means the slack is constantly gathered in, and the weight holds on without increasing the friction, as by hanging under the winch it counteracts the pressure upwards on its axis. Press.

The power of this machine is very great, being as 1 to 1136 nearly, and capable by a trifling addition of any other proportion. It is applicable to many purposes beside cyder-pressing, and is more simple, and less liable to injury, than any other which has fallen under our observation. Perhaps, however, it would be an improvement to use, instead of the ropes and pulleys, by which the lever E is moved, a small wheel or pinion of 10 or 12 teeth, on the axis of the winch W (n° 2.), and a stiff beam *e n* down from the lever, having on its lower end an iron rack, of which the teeth take into those of the pinion. The action of these teeth would, in our opinion, be less diminished by friction and obliquity, than the pulleys are by friction and the stiffness of the rope; and the machine would retain all its other advantages.

Press used by Joiners, to keep close the pieces they have glued, especially panels, &c. of wainscot, is very simple, consisting of four members; viz. two screws, and two pieces of wood, four or five inches square, and two or three feet long; whereof the holes at the two ends serve for nuts to the screws.

Press used by Inlayers, resembles the joiner's press, except that the pieces of wood are thicker, and that only one of them is moveable; the other, which is in form of a tressel, being sustained by two legs or pillars, jointed into it at each end. This press serves them for sawing and cleaving the pieces of wood required in marquetry or inlaid work.

Founder's Press, is a strong square frame, consisting of four pieces of wood, firmly joined together with tenons, &c. This press is of various sizes, according to the sizes of the moulds; two of them are required to each mould, at the two extremes whereof they are placed; so as that, by driving wooden wedges between the mould and the sides of the presses, the two parts of the mould wherein the metal is to be run may be pressed close together.

Printing-Press. See *Printing-Press*.

Rolling-Press, is a machine used for the taking off prints from copper-plates. It is much less complex than that of the letter-printers. See its description and use under the article *Rolling-press Printing*.

Press, in *Coining*, is one of the machines used in striking of money; differing from the balance, in that it has only one iron bar to give it motion, and press the moulds or coins; is not charged with lead at its extreme, nor drawn by cordage. See Coining.

Binder's Cutting-Press, is a machine used equally by book-binders, stationers, and pasteboard-makers; consisting of two large pieces of wood, in form of cheeks, connected by two strong wooden screws; which, being turned by an iron bar, draw together, or set asunder, the cheeks, as much as is necessary for the putting in the books or paper to be cut. The cheeks are placed lengthwise on a wooden stand, in the form of a chest, into which the cuttings fall. Aside of the cheeks are two pieces of wood, of the same length with the screws, serving to direct the cheeks, and prevent their opening

unequally.

unequally. Upon the cheeks the plough moves, to which the cutting-knife is faftened by a fcrew; which has its key, to difmount it, on occafion, to be fharpened.

The plough confifts of feveral parts; among the reft a wooden fcrew or worm, which, catching within the nuts of the two feet that fuftain it on the cheeks, brings the knife to the book or paper which is faftened in the prefs between two boards. This fcrew, which is pretty long, has two directories, which refemble thofe of the fcrews of the prefs. To make the plough flide fquare and even on the cheeks, fo that the knife may make an equal paring, that foot of the plough where the knife is not fixed, flides in a kind of groove, faftened along one of the cheeks. Laftly, the knife is a piece of fteel, fix or feven inches long, flat, thin, and fharp, terminating at one end in a point, like that of a fword, and at the other in a fquare form, which ferves to faften it to the plough. See *Book-Binding*.

As the long knives ufed by us in the cutting of books or papers, are apt to jump in the cutting thick books, the Dutch are faid to ufe circular knives, with an edge all round; which not only cut more fteadily, but laft longer without grinding.

Press, in the *Woollen Manufactory*, is a large wooden machine, ferving to prefs cloths, ferges, rateens, &c. thereby to render them fmooth and even, and to give them a glofs.

This machine confifts of feveral members; the principal whereof are the cheeks, the nut, and the worm or fcrew, accompanied with its bar, which ferves to turn it round, and make it defcend perpendicularly on the middle of a thick wooden plank, under which the ftuffs to be preffed are placed. The calender is alfo a kind of prefs, ferving to prefs or calender linens, filks, &c.

Liberty of the Press. See *Liberty of the Prefs.*

PRESSING, in the manufactures, is the violently fqueezing a cloth, ftuff, &c. to render it fmooth and gloffy.

There are two methods of preffing, viz. cold and hot.

As to the former, or cold preffing: After the ftuff has been fcoured, fulled, and fhorn, it is folded fquare in equal plaits, and a fkin of vellum or pafteboard put between each plait. Over the whole is laid a fquare wooden plank, and fo put into the prefs, which is fcrewed down tight by means of a lever. After it has lain a fufficient time in the prefs, they take it out, removing the pafteboards, and lay it up to keep. Some only lay the ftuff on a firm table after plaiting and pafteboarding, cover the whole with a wooden plank, and load it with a proper weight.

The method of preffing hot is this: When the ftuff has received the above preparations, it is fprinkled a little with water, fometimes gum-water; then plaited equally, and between each two plaits are put leaves of pafteboard; and between every fixth and feventh plait, as well as over the whole, an iron or brafs plate well heated in a kind of furnace. This done, it is laid upon the prefs, and forcibly fcrewed down. Under this prefs are laid five, fix, &c. pieces at the fame time, all furnifhed with their pafteboards and iron-plates. When the plates are well cooled, the ftuffs are taken out and ftitched a little together to keep them in the plaits. This manner of preffing was only invented to cover the defects of the ftuffs; and, accordingly, it has been frequently prohibited.

Pressing, or *Impreffing*. See Impressing.

PRESSION, or pressure, in the Cartefian Philofophy, is a fuppofed impulfive kind of motion, or rather an endeavour to move, impreffed on a fluid medium, and propagated through it.

PRESSURE of air. See Pneumatics.

Pressure of Fluids. See Hydrostatics and Pneumatics.

PREST, is ufed for a duty in money, to be paid by the fheriff on his account, in the exchequer, or for money left or remaining in his hands: 2 & 3 Edw. VI. c. 4.

Prest-Money, is fo called from the French word *preft*, that is, *promptus*, *expeditus*; for that it binds thofe who receive it, to be ready at all times appointed, being commonly meant of foldiers.

PRESTATION-money, is a fum of money paid yearly by archdeacons and other dignitaries to their bifhop, *pro exteriori jurifdictione.*

Prestation *(præftatio)*, was anciently ufed for other payments: *Et quieti fint de præftatione muragii.* Chart. Hen. VII. Sometimes alfo for pourveyance.

PRESTEIGN is a town in Radnorfhire, diftant 149 miles weft-north-weft from London, in the direct road to Aberyftwith, and throughout South Wales, in N. Lat. 52° 12′, bounded to the north and north-eaft by Herefordfhire. It is a neat well built town, with clean and regular ftreets, and is the refidence of many genteel families. The neighbourhood abounds with all the comforts and conveniencies of life. It is feated on a gravelly foil on the banks of the river Lug, and at the head of a very fertile vale: the mountains to the weft and north-weft of the town forming, as it were, an amphitheatre round it. The name of it in Welfh is *Slan-Andras*, which is fuppofed to be derived from the church, which is dedicated to Saint Andrew. The town is divided into four wards, which have each a feparate jurifdiction, feparate officers, levies, &c. The curfew-bell of William the Conqueror ftill remains in this place, and is rung every night. It is a borough by prefcription, and is governed by a bailiff annually elected, and fworn in by a fteward appointed by the crown. The living is a rectory and vicarage united, and reported to be worth from L. 500 to L. 600 *per annum*; the parifh lying in two counties. Here is an excellent free fchool well endowed. The county hall, the county gaol, the county bridewell, and houfe of correction, are kept in this place. The markets are held on Saturdays; and there are two fairs in the year. About a century and a half ago Prefteign was confiderably larger; had a good woollen manufactory, of which the very large buildings now ftanding (formerly belonging to clothiers) bear ample teftimony; but a fire, fucceeded by the plague, in the town about the year 1636, reduced the fame, and with it, its confequence as a manufacturing town. The healthinefs of its fituation cannot be better afcertained than by the regifter of births and burials. The parifh embraces at leaft a circle of 19 miles; and the average of burials for the laft feven years was only 26 perfons *per annum*, and that of births for the fame time was 42; and of the former upwards of 18 were from 80 to 100 years old.

PRESTER (John, or Jean), an appellation formerly given to an emperor of the Tartars who was overcome and killed by Jenghiz Khan. Since that time it has been given to the emperor of Abyſſinia or Ethiopia; however, in Ethiopia itſelf this name is utterly unknown, the emperor being there called the *grand negus*.

PRESTER, a meteor, conſiſting of an exhalation thrown from the clouds downwards with ſuch violence, as that by the colliſion it is ſet on fire. The word is Greek, πρηστης, the name of a kind of ſerpent; called alſo *dipſas*, to which this meteor is ſuppoſed to bear a reſemblance. The preſter differs from the thunderbolt in the manner of its inflammation; and in its burning and breaking every thing it touches with greater violence.

PRESTER, a word uſed by ſome to expreſs the external part of the neck, which is uſually inflated in anger.

PRESTIMONY, in canon law, is derived *a præſtatione quotidiana;* and is, by ſome, defined to be a kind of benefice, ſerved by a ſingle prieſt. Others ſay, it is the incumbency of a chapel, without any title or collation; ſuch as are moſt of thoſe in caſtles, where prayers or maſs are ſaid; and which are mere unendowed oratories. Whence the term is alſo applied, in the Romiſh church, to certain perpetual offices beſtowed on canons, religious, or others, for the ſaying of maſſes, by way of augmentation of their livings. Others think it is a leaſe, or conceſſion of any eccleſiaſtical fund or revenue, belonging to a monaſtery, to be enjoyed during life. Du Moulin calls it a *profane benefice*, which, however, has a perpetual title, and an eccleſiaſtical office, with certain revenues attached to it; which the incumbent is allowed to ſell, and which may be poſſeſſed without tonſure; ſuch as the lay church-wardens of Notre-dame. He adds, that, in propriety, the canonries of chapels are benefices of this nature. The moſt probable opinion ſeems to be, that preſtimony is a fund, or revenue, appropriated by the founder for the ſubſiſtence of a prieſt, without being erected into any title of benefice, chapel, prebend, or priory; and which is not ſubject either to the pope or to the ordinary, but whereof the patron, and thoſe who have a right from him, are the collators, and nominate and confer *pleno jure.*

PRESTO, in the Italian muſic, intimates to perform quick; as *preſtiſſimo* does extremely quick.

PRESTON, a town of Lancaſhire in England, ſeated on the river Ribble, over which there is a handſome ſtone bridge. Here is held a court of chancery, and other offices of juſtice for the county palatine of Lancaſter. It is noted for the defeat of the rebels here in 1715, when they were all made priſoners, and ſent up to London. W. Long. 2. 26. N. Lat. 53. 45.

PRESTRE. See VAUBAN.

PRETENSED or PRETENDED right, in law, is where one is in poſſeſſion of lands and tenements, which another, who is out, claims and ſues for. Here the pretenſed right is in him who ſo claims or ſues.

PRETERITE, in grammar, a tenſe which expreſſes the time paſt, or an action completely finiſhed; as, *ſcripſi*, "I have written." See PERFECT and GRAMMAR.

PRETERITION, or PRETERMISSION, in rhetoric, a figure whereby, in pretending to paſs over a thing untouched, we make a ſummary mention thereof. *I will not ſay he is valiant, he is learned, he is juſt*, &c. The moſt artful praiſes are thoſe given by way of preterition. See ORATORY.

PRETEXT, a colour or motive, whether real or feigned, for doing ſomething.

TOGA PRETEXTA, among the ancient Romans, a long white gown, with a border of purple round the edges, and worn by children of quality till the age of puberty, *viz.* by the boys till 17, when they changed it for the *toga virilis:* and by the girls till marriage.

PRETIUM SEPULCHRI, in old law books, &c. thoſe goods accruing to the church wherein a corpſe is buried. In the Iriſh canons, lib. xix. cap. 6. it is ordered, that along with every body that is buried, there go his cow, horſe, apparel, and the furniture of his bed; none of which may be diſpoſed of otherwiſe than for the payment of debts, &c. as being familiars and domeſtics of the deceaſed.

PRETOR, a magiſtrate among the ancient Romans, not unlike our lord chief juſtices, or lord chancellor, or both in one; as being veſted with the power of diſtributing juſtice among the citizens. At firſt there was only one pretor; but afterwards, another being created, the firſt or chief one had the title of *prætor urbanus*, or the "city pretor:" the other was called *peregrinus*, as being judge in all matters relating to foreigners. But, beſides theſe, there were afterwards created many provincial pretors; who were not only judges, but alſo aſſiſted the conſuls in the government of the provinces, and even were inveſted with the government of provinces themſelves.

PRETORIAN GUARDS, in Roman antiquity, were the emperor's guards, who at length were increaſed to 10,000: they had this denomination, according to ſome, from their being ſtationed at a place called *Prætorium:* their commander was ſtyled *præfectus prætorii.*

PRETORIUM, or PRÆTORIUM, among the Romans, denoted the hall or court wherein the pretor lived, and wherein he adminiſtered juſtice.

It likewiſe denoted the tent of the Roman general, wherein councils of war, &c. were held: alſo a place in Rome where the Pretorian guards were lodged.

PREVARICATION, in the civil law, is where the informer colludes with the defendants, and ſo makes only a ſham proſecution.

PREVARICATION, in our laws, is when a man falſely ſeems to undertake a thing, with intention that he may deſtroy it; where a lawyer pleads booty, or acts by colluſion, &c.

It alſo denotes a ſecret abuſe committed in the exerciſe of a public office, or of a commiſſion given by a private perſon.

PRIAM, king of Troy, was the ſon of Laomedon. He was carried into Greece after the taking of that city by Hercules; but was afterwards ranſomed, on which he obtained the name of *Priam*, a Greek word ſignifying "ranſomed." At his return he rebuilt Ilium, and extended the bounds of the kingdom of Troy, which became very flouriſhing under his reign. He married Hecuba, the daughter of Ciſſeus king of Thrace, by whom he had 19 children; and among the reſt Paris, who

who carried off Helen, and occasioned the ruin of Troy, which is supposed to have been sacked by the Greeks about 1184 B. C. when Priam was killed by Pyrrhus the son of Achilles at the foot of an altar where he had taken refuge, after a reign of 52 years. See Troy.

PRIAPISMUS, or priapism, is an erection of the penis without any concomitant pain, or the consent of other parts. It is thus called, because the person in this state resembles the lewd god Priapus. Cœlius Aurelianus says it is a palsy of the seminal vessels, and other nerves distributed to the parts about the penis, by the distension of which this disorder is produced. It is of the same nature as the satyriasis. See Medicine, n° 372.

PRIAPUS, in Pagan worship, the son of Bacchus and Venus, who presided over gardens and the most indecent actions. He was particularly adored at Lampsacus, a city at the mouth of the Hellespont, said to be the place of his birth; and his image was placed in gardens to defend them from thieves and birds destructive to fruit. He was usually represented naked, with a stern countenance, matted hair, and holding either a wooden sword or sickle in his hand, and with a monstrous privity; from whence downward his body ended in a shapeless trunk. The sacrifice offered to this obscene deity was the ass; either on account of the natural uncomeliness of this animal, and its propensity to venery, or from the disappointment which Priapus met with on his attempting the chastity of Vesta, while that goddess was asleep, when she escaped the injury designed her by her being awaked by the braying of old Silenus's ass.

PRICE (Rev. Richard), D. D. L. L. D. fellow of the Royal Society of London, and of the Academy of Sciences, New England, was born at Tynton in Glamorganshire, February 22. 1723. His father was a dissenting minister at Bridgend in that county, and died in 1739. At eight years old he was placed under a Mr Simmons of Neath; and in four years removed to Pentwyn in Caermarthenshire under the Rev. Samuel Jones, whom he represented as a man of a very enlarged mind, and who first inspired him with liberal sentiments of religion. Having lived as long with him as with Mr Simmons, he was sent to Mr Griffith's academy at Talgarth in Breconshire. In 1740 he lost his mother; and on this he quitted the academy and came to London. Here he was settled at that academy, of which Mr Eames was the principal tutor, under the patronage of his uncle the Rev. S. Price, who was copastor with Dr Watts upwards of 40 years. At the end of four years he left this academy, and resided with Mr Streatfield of Stoke Newington in the quality of domestic chaplain, while at the same time he regularly assisted Dr Chandler at the Old Jewry, and occasionally assisted others. Having lived with Mr Streatfield near 13 years, on his death and his uncle's he was induced to change his situation, and in 1757 married Miss S. Blundell of Leicestershire. He then settled at Hackney, but being shortly after chosen minister at Newington Green, he lived there until the death of his wife, which was in 1786, when he returned to Hackney. He was next chosen afternoon-preacher at the meeting-house in Poor Jewry-street, but this he resigned on being elected pastor of the Gravel-pit meeting Hackney, and afternoon-preacher at Newington Green. These he resigned with a farewel-sermon in February 1791. Shortly after he was attacked with a nervous fever, which disappearing was succeeded by a disorder in his bladder, which reduced him to such a degree that, worn out with agony and disease, he died without a groan on the 19th April 1791. He left his property to a sister and two nephews.

Price.

Dr Kippis, speaking of his learning and pursuits, observes *, that "his chief aim was to lay a foundation for solid knowledge, by an application to sciences of the noblest kind. It was on the great and fundamental principles and obligations of morality, on the higher species of mathematics, on the sublimer parts of natural philosophy, on the true basis of government, and on the questions which relate to the essential welfare and dignity of man, that his studies were employed; and in the prosecution of these studies he not only enriched his own mind, but was enabled to become of eminent service to his country and to the world. In his moral writings he has laboured with distinguished ability to build the science of ethics on an immutable basis; and what he has advanced will always stand high in estimation as one of the strongest efforts of human reason in favour of the system he has adopted. For myself (adds Dr Kippis), I scruple not to say, that I regard the treatise referred to as a rich treasure of valuable information, and as deserving to be ranked among the first productions of its kind. With respect to his other ethical works, every one must admire the zeal, earnestness, and strength, with which he endeavours to lead men into pious views of God, of providence and prayer; and to promote the exercise of devout and amiable dispositions. In consequence of his profound knowledge in mathematical calculations, he was qualified at a particular crisis for being of singular utility to his fellow-citizens. A number of schemes for insurance for lives, and the benefit of survivorship, promising mighty advantages, were rising up in the metropolis. These ruinous schemes would have been carried to great excess had not Dr Price stepped forward and dispelled the delusion. Gratitude will not allow us to forget the ability and spirit with which he awakened the attention of his countrymen to the reduction of the national debt. With him it was that the scheme of the present minister for that purpose is understood to have originated. What crowned the whole of his character was, its being an assemblage of the most amiable and excellent private virtues. His piety was sincere, humble, and fervent; his soul pure and elevated; in his views disinterested and noble; and in his manners mild and gentle: the applause of his talents and virtues will be transmitted to future ages, and he will be united in the catalogue with the most eminent benefactors of mankind."

* *Address at his Funeral*, 8vo.

This is the panegyric of a friend; but with few abatements it will be admitted by every candid reader. In morals Dr Price's principles were those of Cudworth and Clarke; and by many who have themselves adopted a very different theory, he is allowed to have defended those principles with greater ability than any other writer in the English language (see *Moral Philosophy*, n° 14.) In metaphysics he was perhaps too great an admirer of Plato, from whom he has borrowed a doctrine concerning ideas which we confess ourselves unable to comprehend. He was a firm believer in the immateriality of the soul; but, with Dr Law, the late learned bishop of Carlisle, he thought, that from death to the resurrection of the body it remains in a dormant or

qui-

Price.

quiescent state. He contended for its indivisibility, but maintained at the same time its extension; which furnished Dr Priestley with some advantages in their celebrated controversy, which his own acuteness would never have obtained. In propagating his political principles, which were republican, he sometimes expressed himself with undue vehemence; and he was a zealous enemy to all religious establishments which, in his opinion, encroach upon that liberty wherewith Christ has made us free. His faith respecting the Son of God was what has been called sometimes *low Arianism* and sometimes *Semi-arianism*. From a very early age he claimed the privilege of thinking for himself on every subject. His father was a rigid Calvinist, and spared no pains to instil his own theological dogmas into the tender mind of his son; but young Richard would often start his doubts and difficulties, and sometimes incur the old man's displeasure by arguing against his favourite system with an ingenuity that perplexed, and a solidity that could not be easily overturned. He had once the misfortune to be caught reading a volume of Clarke's sermons, which his father in great wrath snatched from him and threw into the fire. Perhaps he could not have taken a more effectual method to make the book a favourite, or to excite the young man's curiosity after the other works of the same author; and it is by no means improbable that this orthodox bigotry contributed more than any other circumstance to lay the foundation of his son's Arianism.

But whatever may be thought of Dr Price's speculative opinions, whether political or religious, his virtues in private life have never been called in question. Of his practical religion it is impossible to speak in terms too high. There was a fervour even in his public prayers which indicated the strongest sensibility as well as sincerity in himself, and communicated its warmth to those who joined with him. But in his family devotions he gave still fuller scope to the pious emotions of his soul, and proved to those friends who were occasionally present at them how deeply he felt religious impressions, and how happily he blended in this as well as in other things the cool decisions of the understanding with the amiable and exalted sensibilities of the heart.

But it was not in devotion only that these sensibilities were displayed. He was as exemplary in affection to his relatives as in love to his Maker. Of this he gave a striking though private instance before he first quitted his native place to try his fortune in London. His father had left to an elder brother by a former marriage a very considerable fortune; to Richard he left a mere trifle; and to each of two sisters still less. Our author divided his share between his sisters, reserving to himself only a few pounds to defray the expences of his journey, and trusting for his future support to the blessing of God upon his talents and his industry. As in early life he was an affectionate and generous brother, in old age he was a loving and attentive husband. His wife, who for a considerable time before her death was almost wholly helpless, found during the last years of her life hardly any enjoyment except in a game at whist; and though our Doctor disliked cards as a waste of time, and never touched them on any other occasion, to amuse her he would sit down every evening to the card-table, and play till it was late, with a cheerfulness and good humour which charmed every person who had the happiness of viewing him in that endearing situation.

Yet, though thus attentive to the obligations of domestic life, he did not suffer his private affections to encroach upon his social duties. His talents and his labours were ever ready at the call of friendship; nay, so much did his nature abound with the milk of human kindness, that he could not resist without extreme reluctance even troublesome and unreasonable solicitations. His hours of study and retirement were frequently broken in upon by applications for assistance and advice, especially in matters relating to annuities and life-insurances; and in this way he sacrificed much of his personal convenience to individuals of whom he knew but little, and from whom he would accept of no pecuniary recompense. His good nature in this respect amounted almost to a foible; and subjected him to importunities and loss of time, of which he would sometimes complain as interfering materially with more important and more generally useful studies.

Whilst he thus obliged the rich by his mental talents, he succoured the poor with his earthly substance. A fifth part of his annual income was regularly devoted to charitable purposes; and he was laudably anxious to distribute it in such a way as might produce the greatest good. In the practice of this, and indeed of all his virtues, he was utterly devoid of ostentation. Simplicity and humility were among the strong features of his character. No man was ever less sensible of his own excellence, or less elated by his own celebrity; and in no man was the dignity of artless manners and unaffected modesty more happily displayed.

His face was the true index of his mind. It beamed with philanthropy; and when lighted up in conversation with his friends, assumed an aspect peculiarly pleasing. His person was slender, and rather below the common size, but possessed of great muscular strength and remarkable activity. A habit of deep thought had given a stoop to his figure, and he generally walked a brisk pace with his eyes on the ground, his coat buttoned, one hand in his pocket, and the other swinging by his side.

It is natural to suppose that such a man as Dr Price, some of whose writings were translated into foreign languages, would be very generally respected in the republic of letters, and have many correspondents. The supposition is well founded. In 1763 or 1764 he was chosen a fellow of the Royal Society, and contributed largely to the transactions of that learned body; in 1769 he received from Aberdeen a diploma creating him DD.; and in 1783 the degree of LL.D. was conferred upon him by the college of Yale in Connecticut. As in 1770 he had refused an American degree which had been conveyed to him by Dr Franklin, his acceptance of one 13 years afterwards can be attributed only to his extravagant attachment to a republican form of government; which was the greatest defect in his character, and shows what prejudices the most vigorous mind will imbibe by thinking always on the same subjects, and in the same track. Among his correspondents, the most eminent in his own country were the late Lord Chatham, Lord Stanhope, Lord Lansdowne, the late bishops of Carlisle and St Asaph, and the present bishop of Landaff; Mr Hume, Mr Harris of Salisbury,

Price. lisbury, Dr Gregory of Edinburgh, and the celebrated Mr Howard, who lived with him on terms of the greatest intimacy; in America he corresponded with Dr Franklin, Dr Chauncey, Mr Adams, and others; and in France with the celebrated Turgot, the Duke de Rochefoucault, and several of the first national assembly. One of his female correspondents sketched his character with great justness many years ago under the fictitious but well applied name of *Simplicius*; and with this character we shall close these short memoirs.

"While the vain man is painfully striving to outshine the company and to attract the admiration by false wit, forced compliments, and studied graces, he must surely be mortified to observe how constantly Simplicius engages their attention, respect, and complacency, without having once thought of himself as a person of any consequence among them. Simplicius imparts his superior knowledge, when called upon, as easily and naturally as he would tell you what it is o'clock; and with the same readiness and good will informs the most ignorant or confers with the most learned. He is as willing to receive information as to give it, and to join the company, as far as he is able, in the most trifling conversation into which they may happen to fall as in the most serious and sublime. If he disputes, it is with as much candour on the most important and interesting as on the most insignificant subjects; and he is not less patient in hearing than in answering his antagonist. If you talk to him of himself or his works, he accepts praise or acknowledges defects with equal meekness, and it is impossible to suspect him of affectation in either. We are more obliged by the plain unexaggerated expressions of his regard, than by the compliments and attentions of the most accomplished pattern of high breeding; because his benevolence and sincerity are so strongly marked in every look, word, and action, that we are convinced his civilities are offered for our sakes, not for his own, and are the natural effects of real kindness, not the studied ornaments of behaviour. Every one is desirous to show him kindness in return, which we know will be accepted just as it is meant. All are ready to pay him that deference which he does not desire, and to give him credit for more than he assumes, or even more than he possesses. With a person ungraceful, and with manners unpolished by the world, his behaviour is always proper, easy, and respectable; as free from constraint and servility in the highest company, as from haughtiness and insolence in the lowest. His dignity arises from his humility; and the sweetness, gentleness, and frankness of his manners, from the real goodness and rectitude of his heart, which lies open to inspection in all the fearlessness of truth, without any need of disguise or ornament."

Such was Dr Price.—Of his public principles men will think differently; of his private worth there can be but one opinion. He will live in the memory of his friends till memory has lost her power. To posterity his works will be his monument. They are: A Review of the principal Questions and Difficulties in Morals, 8vo, 1758; Dissertations on Providence, &c. 8vo, 1767; Observations on Reversionary Payments, &c. 8vo, 1771; Appeal on the National Debt, &c. 8vo, 1773; Observations on the Nature of Civil Liberty, 1776; on Materialism and Necessity, in a correspondence between Dr Price and Dr Priestley, 1779; on Annuities, Assurances, Population, &c. 8vo, 1779; on the Population of England, 1780; on the Public Debts, Finances, Loans, &c. 8vo, 1783; on Reversionary Payments, 2 vols, 1783; on the importance of the American Revolution, 1784; besides Sermons, and a variety of papers in the Philosophical Transactions on astronomical and other philosophical subjects.

Pride. PRIDE, inordinate and unreasonable self-esteem, attended with insolence and rude treatment of others.—It is frequently confounded with vanity, and sometimes with dignity; but to the former passion it has no resemblance, and in many circumstances it differs from the latter. Vanity is the parent of loquacious boasting; and the person subject to it, if his pretences be admitted, has no inclination to insult the company. The proud man, on the other hand, is naturally silent, and, wrapt up in his own importance, he seldom speaks but to make his audience feel their inferiority. It is this circumstance which distinguishes pride from dignity, and constitutes its sinfulness. Every man possessed of great powers of mind is conscious of them, and feels that he holds a higher rank in the scale of existence than he whose powers are less. If he recollect, at the same time, that he has nothing which he did not receive, and that his superiority is owing to the good pleasure of Him who forms his creatures differently, as the potter forms his clay; he will be so far from insulting his inferiors, that when necessarily in company with them, he will bear with their foibles, and, as far as is proper, make them lose sight of the distance which the laws of God and man have for ever placed between them and him. This condescension, however, if he be a man of dignity, will never lead him to join with them in any mean or dirty action. He will even excuse in them many things which he would condemn in himself, and give them his good wishes, after they have forfeited his esteem. Such a character is amiable and respectable, and what every man should labour to obtain. From the weakness of human nature, however, it is too apt to degenerate into pride.

To a man of great intellectual powers and various erudition, the conversation of ordinary persons affords neither instruction nor amusement; and such conversation, when often repeated, must, from the nature of things, become tedious and irksome. But it requires great command of temper and of manners to prevent uneasiness long felt from sometimes betraying itself by external symptoms, such as peevish expressions, a forbidding look, or absence of mind; and these are the infallible indications of contempt for the company, the very worst ingredient in the passion of pride. If this contempt be often excited, it will be formed into a habit; and the proud man will be so much under its influence, as to insult his inferiors, and sometimes his equals, without forming the resolution to insult either the one or the other. Such a character is hateful to every company, and is so far from indicating true dignity of mind in him to whom it belongs, that it is obviously associated with meanness, and indicates a consciousness of some radical defect. He who possesses real and conspicuous merit has no occasion to depress others for the purpose of raising himself; his superiority will be cheerfully acknowledged: but when a man of undoubted con-

Pride || Priene.

eminence in one respect, is so swollen with pride as to make him wish to appear great in all respects, he has no other means of enforcing his ill-founded claim, than displaying his acknowledged superiority, with such insolence as may drive at a distance from him every person by whom he is conscious that in many instances he might be more than rivalled. Whoever is proud of knowledge, would do well to consider how much knowledge he wants.

The same observations which we have made on pride of parts will apply to every other species of pride, such as pride of birth, office, or riches, &c. The peace and order of society require difference of rank, accompanied with different degrees of authority; and he who inherits a title or office from his ancestors, may without pride be conscious of his superiority, provided he forget not that such superiority is conferred on families and individuals, not for their own sakes, but for the good of the community. The peer, who keeps this circumstance in mind, may maintain his station, and repress the forward petulance of the plebeian, without giving offence to any thinking man; but if he dwell upon his rank with too much complacency, he will in process of time be apt to consider himself and his family as superior by nature to those upon whom no title has been conferred, and then his pride will become intolerable. If we could trace our descents, says Seneca, we should find all slaves to come from princes, and all princes from slaves. To be proud of knowledge, is to be blind in the light; to be proud of virtue, is to poison ourselves with the antidote; to be proud of authority, is to make our rise our downfal. The best way to humble a proud man is to neglect him.

PRIDEAUX (Humphry) was born at Padstow in Cornwall in 1648, and was honourably descended by both parents. Three years he studied at Westminster under Dr Busby; and then was removed to Christchurch, Oxford. Here he published, in 1676, his *Marmora Oxoniensia ex Arundelianis, Seldenianis, aliisque conflata, cum perpetuo Commentario*. This introduced him to the lord chancellor Finch, afterward earl of Nottingham, who in 1679 presented him to the rectory of St Clements near Oxford, and in 1681 bestowed on him a prebend of Norwich. Some years after he was engaged in a controversy with the Papists at Norwich, concerning the validity of the orders of the church of England, which produced his book upon that subject. In 1688 he was installed in the archdeaconry of Suffolk; to which he was collated by Dr Lloyd, then bishop of Norwich. In 1691, upon the death of Dr Edward Pococke, the Hebrew professorship at Oxford being vacant, was offered to Dr Prideaux, but he refused it. In 1697, he published his Life of Mahomet, and in 1702 was installed dean of Norwich. In 1710 he was cut for the stone, which interrupted his studies for more than a year. Some time after his return to London, he proceeded with his Connection of the History of the Old and New Testament; which he had begun when he laid aside the design of writing the History of Appropriations. He died in 1724.

Chandler's Travels in Asia Minor.

PRIENE, an ancient town of Asia Minor. It is now called *Samsun*, and *Samsun-kalesi*, which do not however appear to be very recent. It was taken in 1391 by Bajazet, who subdued Ionia. It had formerly, without including the citadel, three gateways; one of which was towards Kelibesh, an adjoining village; and without it are vaults of sepulchres. The entrance was not wide. A part of the arch, consisting of a single row of massive stones, still remains; but those on which it rests are so corroded by age, broken, or distorted, as to seem every moment ready to yield and let down their load. A rugged way leads to a second opening in the wall opposite to this, and about a mile from it; beyond which are likewise vaults of sepulchres. Between these was a gate facing to the plain; and on the left hand going out of it is a hole, resembling the mouth of an oven, in the side of a square tower; and over it an inscription in small characters, exceedingly difficult to be read. It signifies, that a certain Cyprian in his sleep had beheld Ceres and Proserpine arrayed in white; and that in three visions they had enjoined the worship of a hero, the guardian of the city, and pointed out the place where, in obedience to them, he had erected the god. This was probably some local hero, whose little image was set in the wall, and whose name and memory have perished.

Priest.

PRIEST, a person set apart for the peformance of sacrifice, and other offices and ceremonies of religion. Before the promulgation of the law of Moses, the first-born of every family, the fathers, the princes, and the kings, were priests. Thus Cain and Abel, Noah, Abraham, Melchizedec, Job, Isaac, and Jacob, offered themselves their own sacrifices. Among the Israelites, after their exod from Egypt, the priesthood was confined to one tribe, and it consisted of three orders, the *high*-priest, *priests*, and *Levites*. The priesthood was made hereditary in the family of Aaron, and the first-born of the oldest branch of that family, if he had no legal blemish, was always the high-priest. This divine appointment was observed with considerable accuracy till the Jews fell under the dominion of the Romans, and had their faith corrupted by a false philosophy.—Then, indeed, the high-priesthood was sometimes set up to sale, and instead of continuing for life, as it ought to have done, it seems, from some passages in the New Testament, to have been nothing more than an annual office. There is sufficient reason, however, to believe, that it was never disposed of but to some descendant of Aaron, capable of filling it, had the older branches been extinct. (For the consecration and offices of the Jewish priesthood, we refer our readers to the books of Moses). In the time of David, the inferior priests were divided into 24 companies, who were to serve in rotation, each company by itself, for a week. The order in which the several courses were to serve was determined by lot; and each course was in all succeeding ages called by the name of its original chief.—All nations have had their *priests*. The Pagans had *priests* of Jupiter, Mars, Bacchus, Hercules, Osiris, and Isis, &c.; and some deities had *priestesses*. The Mahometans have priests of different orders, called *schiek*, and *mufti*; and the Indians and Chinese have their *bramins* and *bonzes*.

It has been much disputed, whether, in the Christian church, there be any such officer as a *priest*, in the proper sense of the word. The church of Rome, which holds the *propitiatory* sacrifice of the *mass*, has of course her proper *priesthood*. In the church of England, the word *priest* is retained to denote the second order in her hierarchy, but we believe with very different significations, according to the different opinions entertained of the Lord's

Lord's ſupper. Some few of her divines, of great learning, and of undoubted Proteſtantiſm, maintain that the Lord's ſupper is a *commemorative* and *euchariſtical ſacrifice*. Theſe conſider all who are authoriſed to adminiſter that ſacrament as in the ſtricteſt ſenſe *prieſts*. Others hold the Lord's ſupper to be a *feaſt* upon the *one* ſacrifice, once offered on the croſs; and theſe too muſt conſider themſelves as clothed with ſome kind of prieſthood. Great numbers, however, of the Engliſh clergy, perhaps the majority, agree with the church of Scotland, in maintaining that the Lord's ſupper is a rite of no other moral import, than the mere commemoration of the death of Chriſt. Theſe cannot conſider themſelves as *prieſts* in the rigid ſenſe of the word, but only as *preſbyters*, of which the word *prieſt* is a contraction of the ſame import with *elder*. See *Supper of the Lord*.

PRIMÆ viæ, among phyſicians, denote the whole alimentary duct; including the œſophagus, ſtomach, and inteſtines, with their appendages.

PRIMAGE, in commerce, a ſmall duty at the water-ſide, uſually about 12 d. *per* ton, or 6 d. *per* bale, due to the maſter and mariners of a ſhip.

PRIMARY, firſt in dignity, chief, or principal.

Primary Qualities of Bodies. See Metaphysics, n° 152.

PRIMATE, in church-polity, an archbiſhop, who is inveſted with a juriſdiction over other biſhops.

PRIME, primus, an appellation given to whatever is firſt in order, degree, or dignity, among ſeveral things of the ſame or like kind; thus we ſay, the prime miniſter, prime coſt, &c.

Prime is ſometimes uſed to denote the ſame with decimal, or the tenth part of an unit.

Prime-Figure, in geometry, one which cannot be divided into any other figures more ſimple than itſelf, as a triangle among planes, and the pyramid among ſolids.

For prime numbers, in arithmetic, ſee the article Number.

Prime of the Moon, is the new moon when ſhe firſt appears, which is about three days after the change.

Prime Vertical, is that vertical circle which paſſes through the poles of the meridian, or the eaſt and weſt points of the horizon; whence dials projected on the plane of this circle are called *prime vertical*, or *north-and-ſouth dials*.

Prime, in the Romiſh church, is the firſt of the canonical hours, ſucceeding to lauds.

Prime, in fencing, is the firſt of the chief guards. See Guard.

PRIMER seasin, in feodal law, was a feodal burden, only incident to the king's tenants *in capite*, and not to thoſe who held of inferior or meſne lords. It was a right which the king had, when any of his tenants *in capite* died ſeized of a knight's fee, to receive of the heir (provided he were of full age) one whole year's profits of the lands if they were in immediate poſſeſſion, and half a year's profits if the lands were in reverſion expectant on an eſtate for life. This ſeems to be little more than an additional relief, (ſee Relief); but grounded upon this feodal reaſon, That, by the ancient law of feods, immediately upon the death of a vaſſal the ſuperior was entitled to enter and take ſeiſin or poſſeſſion of the land, by way of protection againſt intruders, till the heir appeared to claim it, and receive inveſtiture: and for the time the lord ſo held it, he was entitled to take the profits; and unleſs the heir claimed within a year and day, it was by the ſtrict law a forfeiture. This practice however ſeems not to have long obtained in England, if ever, with regard to tenures under inferior lords; but, as to the king's tenures *in capite*, this *prima ſeiſina* was expreſsly declared, under Hen. III. and Ed. II. to belong to the king by prerogative, in contradiſtinction to other lords. And the king was entitled to enter and receive the whole profits of the land, till livery was ſued; which ſuit being commonly within a year and day next after the death of the tenant, therefore the king uſed to take at an average the *firſt-fruits*, that is to ſay, one year's profits of the land. And this afterwards gave a handle to the popes, who claimed to be feodal lords of the church, to claim in like manner from every clergyman in England the firſt year's profits of his benefice, by way of *primitiæ*, or firſt-fruits.—All the charges ariſing by primer ſeiſin were taken away by 12 Car. II. c. 24.

PRIMING, in gunnery, the train of powder that is laid, from the opening of the vent, along the gutter or channel on the upper part of the breech of the gun: which, when fired, conveys the flame to the vent, by which it is further communicated to the charge, in order to fire the piece. This operation is only uſed on ſhipboard at the proof, and ſometimes in garriſon; for, on all other occaſions, tubes are uſed for that purpoſe.

Priming-Wire, in gunnery, a ſort of iron needle employed to penetrate the vent or touch-hole of a piece of ordnance, when it is loaded: in order to diſcover whether the powder contained therein is thoroughly dry and fit for immediate ſervice; as likewiſe to ſearch the vent and penetrate the cartridge, when the guns are not loaded with the looſe powder.

Priming, among painters, ſignifies the laying on of the firſt colour.

PRIMIPILUS, in antiquity, the centurion of the firſt cohort of a legion, who had the charge of the Roman eagle.

PRIMITIÆ, the firſt-fruits gathered of the earth, whereof the ancients made preſents to the gods.

PRIMITIVE, in grammar, is a root or original word in a language, in contradiſtinction to *derivative*; thus, *God* is a primitive; *godly*, a derivative; and *god-like*, a compound.

PRIMOGENITURE, the right of the firſt-born, has among moſt nations been very conſiderable. The firſt-born ſon in the patriarchal ages had a ſuperiority over his brethren, and, in the abſence of his father, was prieſt to the family. Among the Jews, he was conſecrated to the Lord, had a double portion of the inheritance, and ſucceeded in the government of the family or kingdom. It is, however, remarkable, and unqueſtionably ſhows the connection between this inſtitution and the birth and office of our Saviour, that if a woman's firſt child was a girl, neither ſhe, nor the children that came after her, were conſecrated.

In every nation of Europe, the right of primogeniture prevails in ſome degree at preſent, but it did not

prevail always. The law which calls the elder-born to the crown, preferably to the others, was not introduced into France till very late; it was unknown to the first race of kings, and even to the second. The four sons of Clovis shared the kingdom equally among themselves; and Louis le Debonnaire did the same: it was not till the race of Hugh Capet, that the prerogative of succession to the crown was appropriated to the first-born.

By the ancient custom of *Gavel-kind*, still preserved in some parts of our island, primogeniture is of no account; the paternal estate being equally shared by all the sons. And it has been a matter of violent and learned dispute, whether, at the death of Alexander III. Baliol or Bruce was, by the law as it then stood, heir to the crown of Scotland. The former had undoubtedly the right of primogeniture, but the latter stood in one degree of nearer relation to the deceased sovereign; and the Scottish barons, not being able to determine whose claim was best founded, referred the question to Edward I. of England, and thereby involved their country in a long and ruinous war. See SCOTLAND.

PRIMORIE, is a name given by the Slavi to that tract of sea-coast which lies between the two rivers Cettina and Narenta, the first of which is the Nestus and Tiluras, and the second the Narus, of the ancients; comprising what was properly called Dalmatia two ages before our era, and which was known to the Greeks of the low times under the name of *Paratalassia*. Appian informs us, that the Ardei or Vardei possessed many cities there, part of which they seized before the invasion of the Romans, and part they built themselves. We learn also from the *Tabula Pentingeriana*, that after the conquest many of those cities remained, and were inhabited by the conquerors, who also founded new settlements. And indeed were these proofs wanting, the numerous inscriptions found near the sea, and sometimes among the hills, would render it at least probable. The coast is extremely pleasant, the soil fertile, and the situation most convenient for commerce with the inland provinces. By bad management, however, much ground has been lost near the sea, by its being covered with gravel, and by imprudent cultivation of the hills, the impetuous fury of the mountain torrents has rendered a part of it uninhabitable. Macarska is now the only town in the territory, and it appears to have risen out of the ruins of the ancient RATANEUM of Pliny. It formed a part of the Narentan state for several ages, and afterwards, together with the rest of Primorie, passed under the obedience of various Christian princes. It afterwards became subject to the Ottoman Porte, and at last voluntarily subjected itself to the Venetian republic. See DALMATIA and MACARSKA. See also Fortis's *Travels into Dalmatia*, p. 265——318.

PRIMULA, the PRIMROSE: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 21st order, *Preciæ*. The involucrum lies under a simple umbel; the tube of the corolla cylindrical; with the mouth or limb patulous. This genus, including also the polyanthus and auricula, furnishes an excellent collection of low, fibrous-rooted, herbaceous flowery perennials.

1. The primula veris, or spring primrose, has thick and very fibrous roots, crowned by a cluster of large oblong indented rough leaves, and numerous flower-stalks, from about three or four, to five or six inches high; each terminated commonly by one flower.—The varieties are, common yellow-flowered primrose of the woods—white primrose—paper-white—red—double red—double yellow, and double white.—All these flower abundantly in March and April, and continue for a month or six weeks.

The cowslip primrose, or cowslip, has very thick fibrous roots, crowned by a cluster of oblong, indented round leaves, and upright, firm, flower-stalks five or six inches high, terminated each by a cluster of small flowers. The varieties are, Common single yellow cowslip of the meadows—double yellow cowslip—scarlet cowslip—hose-and-hose cowslip; one flower growing out of the bosom of another, the lowermost serving as a calyx; all of which varieties have the flower-stalks crowned by many flowers in branches.—They flower in April and May, continuing in succession a month or six weeks.

2. The polyanthus, has thick fibrous roots, increasing into large bunches, crowned with a cluster of large oblong indented rough leaves; amidst them upright flower-stalks six or eight inches high, terminated mostly by a cluster of several spreading flowers of many different colours in the varieties. The principal are, purple, red, gold, orange-coloured, &c. They all flower beautifully in April and May, and frequently again in autumn; and sometimes even in winter, if the season is mild. The polyanthus is one of the noted prize-flowers among the florists; many of whom are remarkably industrious in raising a considerable variety of different sorts, as well as in using every art to blow them with all requisite perfection; for, among the virtuosi, a polyanthus must possess several peculiar properties in order to be admitted in their collections. The chief properties required in a florist's polyanthus are, 1. The stem or flower-stalk shall be upright, moderately tall, with strength in proportion, and crowned by a good regular bunch of flowers on short pedicles, strong enough to support them nearly in an upright position. 2. The florets of each branch should be equally large, spreading open flat, with the colours exquisite, and the stripes and variegations lively and regular. 3. The eye in the centre of each floret should be large, regular, and bright; and the antheræ, by the florists called the *thrum*, should rise high enough to cover the mouth of the tube or hollow part in the middle of the florets, and render them what they call *thrum-eyed*; but when the style elevates the stigma above the antheræ, the eye of the tube generally appears hollow, showing the stigma in the middle, like the head of a pin, and is rejected as an incomplete flower, though its other properties should be ever so perfect. This pin-eyed polyanthus, however, though rejected by the florists, is the flower in its most perfect state, and great numbers of them are of as beautiful forms and colours as the thrum-eyed varieties.

3. The auricula has a thick fibrous root, crowned by a cluster of oblong, fleshy, broad, serrated, smooth leaves, resembling the shape of a bear's ear; and amidst them upright flower-stalks from about three or four to six or eight inches high, terminated by an umbellate cluster of beautiful flowers, of many different colours

colours in the varieties. All of theſe have a circular eye in the middle of each flower, and of which there are different colours; whence the auriculas are diſtinguiſhed into yellow-eyed, white-eyed, &c. The petals of moſt of the kinds are powdered with an exceeding fine farina or mealy powder, which contributes greatly to the beauty of the flower. They all flower in April or May, continuing a month or ſix weeks in beauty, and ripening plenty of ſeeds in June.

Culture. All the varieties of the common ſpring primroſe multiply ſo faſt by the roots, that it is ſcarce worth while to raiſe them from ſeeds. However, though many ſingle kinds may be raiſed from ſeed, yet parting the roots is the only method by which the double kind can be preſerved; and the ſame thing is to be obſerved of all the reſt.

PRIMUM MOBILE, in the Ptolemaic aſtronomy, the ninth or higheſt ſphere of the heavens, whoſe centre is that of the world, and in compariſon of which the earth is but a point. This they will have to contain all other ſpheres within it, and to give motion to them, turning itſelf, and all them, quite round in 24 hours.

PRINCE, PRINCEPS, in polity, a perſon inveſted with the ſupreme command of a ſtate, independent of any ſuperior.

PRINCE alſo denotes a perſon who is a ſovereign in his own territories, yet holds of ſome other as his ſuperior; ſuch are the princes of Germany, who, though abſolute in their reſpective principalities, are bound to the emperor in certain ſervices.

PRINCE alſo denotes the iſſue of princes, or thoſe of the royal family. In France, before the revolution, they were called *princes of the blood*, and during the ſhort continuance of the conſtitution of 1791, *French princes*. In England the king's children are called *ſons and daughters of England*; the eldeſt ſon is created prince of Wales; the cadets are created dukes or earls as the king pleaſes; and the title of all the children is *royal highneſs*: all ſubjects are to kneel when admitted to kiſs their hand, and at table out of the king's preſence they are ſerved on the knee. See *ROYAL Family*.

PRINCE of the Senate, in old Rome, the perſon who was called over firſt in the roll of ſenators, whenever it was renewed by the cenſors: he was always of conſular and cenſorian dignity. See the article SENATE.

PRINCE's Metal, a mixture of copper and zinc, in imitation of gold. See CHEMISTRY, n° 1154.

PRINCETOWN. See *New JERSEY*.

PRINCE of Wales's Iſland, or *Pulo Penany*, is ſituated in the entrance of the ſtraits of Malacca, in 100 degrees of eaſt longitude, and in five degrees of north latitude. It is about ſeven leagues in length and three in breadth. Its northern extremity runs nearly parallel with the main land at a diſtance of about two miles, by which a fine channel is formed, where the greateſt fleets might ride in perfect ſafety, the height of the ſurrounding mountains acting as a barrier againſt the force of the prevailing winds. The climate, conſidering its vicinity to the equator, is remarkably mild. Eighty degrees is about the mean height of the thermometer at noon, which, during the night, is ſeldom above 70. Its healthfulneſs is certainly not ſurpaſſed by that of any European ſettlement on the coaſt. Out of a garriſon of 300 troops (natives of Hindoſtan), not one died for the ſpace of 14 months; a ſingular fact to be experienced by a new ſettlement in an uncleared country. This great ſalubrity is perhaps the effect of a conſtant ventilation, ſupported by almoſt continued but gentle breezes, added to the dryneſs of the ſoil, the uniform but gradual elevation from the ſea to the foot of the hills preventing thoſe ſtagnations of water which, in tropical latitudes, are ſo highly prejudicial to the health of man.

Phil. ... p. 13.

Prince.

A ridge of beautiful mountains, deeply indented with valleys, and covered with evergreens, divides the iſland longitudinally. Innumerable rivulets receive their origin from theſe mountains, and are remarkable for the tranſparency and coolneſs of their waters. The ſoil, which is light and ſandy near the ſea, gradually changes to a rich clay as it approaches to the high lands. There the ſugar-cane grows with the utmoſt luxuriance, and the moſt plentiful crops of rice are everywhere produced. The gardens have already furniſhed the inhabitants with cabbages and potatoes; and when induſtry ſhall have reached the tops of the mountains, it will be no ſurpriſe to ſee in the plantations moſt of the productions of Europe in their utmoſt perfection. In decorating the landſcapes of this little iſland, nature has been peculiarly laviſh. An aſſemblage of flowering trees and ſhrubs in perpetual bloſſom, and endleſs in the variety of their ſpecies, form the firſt ſhade. Theſe are overtopped by foreſt trees of an immenſe height, which ſpread their vaſt branches on every ſide, and are covered with the richeſt foliage. Here ſtrangers feel with rapture the effect of the breezes, which, from whatſoever quarter they blow, are ſtrongly impregnated with the fragrance of the groves.

The original animal productions of this iſland are very limited. Of quadrupeds, the wild hog, deer, and ſquirrel, nearly comprehend the whole; but the abſence of the tiger and leopard, whoſe numbers and ferocity almoſt render the oppoſite ſhores uninhabitable, amply compenſates for this deficiency. The flying fox and ſquirrel are natives of this iſland; the former a nondeſcript, and a great natural curioſity. Of birds there are alſo but few, and only one which is remarkable for the melody of its notes. The crow and ſparrow, the never-failing attendants on population, have but lately made their appearance. They are now, however, rapidly increaſing and multiplying. All the domeſtic animals arrive here at great perfection.

The ſea which ſurrounds the iſland, affords a vaſt variety of fiſh of the moſt delicious flavour, and its ſhores abundance of the fineſt turtle and oyſters. In no ſituation indeed are the conveniencies and luxuries of life enjoyed in greater profuſion. The advantages of the iſland in a political and commercial view, are too obvious to require to be pointed out.

PRINCE William's Sound, ſituated on the north-weſt coaſt of America, and ſo named by Captain Cook in 1778. The men, women, and children of this ſound are all clothed in the ſame manner. Their ordinary dreſs is a ſort of cloſe frock, or rather robe, which ſometimes reaches only to the knees, but generally down to the ancles. Theſe frocks are compoſed of the ſkins of various animals, and are commonly worn with the hairy ſide outwards. The men often paint their faces of a black colour, and of a bright red, and ſometimes of a bluiſh or leaden hue; but not in any regu-

Prince, Principal.

lar figure. The women puncture or ftain the chin with black, that comes to a point in each of their cheeks. Their canoes are of two forts; the one large and open, the other fmall and covered. The framing confifts of flender pieces of wood, and the outfide is compofed of the fkins of feals, or other fea animals, ftretched over the wood. Their weapons, and implements for hunting and fifhing, are the fame as thofe ufed by the Greenlanders and Efquimaux. Many of their fpears are headed with iron, and their arrows are generally pointed with bone. The food they were feen to eat was the flefh of fome animal, either roafted or broiled, and dried fifh. Some of the former that was purchafed had the appearance of bear's flefh. They alfo eat a larger fort of fern-root, either baked or dreffed in fome other method. Their drink, in all probability, is water; for, in their canoes, they brought fnow in wooden veffels, which they fwallowed by mouthfuls. Our knowledge of the animals of this part of the American continent is entirely derived from the fkins that were brought by the natives for fale. Thefe were principally of bears, common and pine martins, fea-otters, feals, racoons, fmall ermines, foxes, and the whitifh cat or lynx. The birds found here were the halcyon, or great king's-fifher, which had fine bright colours; the white-headed eagle, and the humming-bird. The fifh that were principally brought to market for fale were torfk and halibut. The rocks were almoft deftitute of fhell-fifh; and the only other animal of this tribe that was obferved was a reddifh crab, covered with very large fpines. Few vegetables of any kind were obferved; and the trees that chiefly grew about this found were the Canadian fpruce pine, fome of which were of a confiderable fize. E. Long. 115. 21. N. Lat. 59. 33.

PRINCIPAL, the chief and moft neceffary part of a thing. The principal of a college or hall is the mafter thereof.

In commerce, principal is the capital of a fum due or lent; fo called in oppofition to intereft. See INTEREST.

It alfo denotes the firft fund put by partners into a common ftock, by which it is diftinguifhed from the calls or acceffions afterwards required.

PRINCIPAL, in mufic. See FUNDAMENTAL, in mufic, and GENERATOR, in mufic.

PRINCIPAL, in law, is either the actor or abfolute perpetrator of the crime, who is called a *principal*, in the firft degree; or he who is prefent, aiding and abetting the fact to be done, who is denominated a *principal* in the fecond degree. The prefence of a principal need not always be an actual immediate ftanding by, within fight or hearing of the fact; but there may be alfo a conftructive prefence, as when one commits a robbery or murder, and another keeps watch or guard at fome convenient diftance. And this rule has alfo other exceptions; for, in cafe of murder by poifoning, a man may be a principal felon by preparing and laying the poifon, or giving it to another (who is ignorant of its poifonous quality) for that purpofe; and yet not adminifter it himfelf, nor be prefent when the very deed of poifoning is committed. And the fame reafoning will hold, with regard to other murders committed in the abfence of the murderer, by means which he had prepared before-hand, and which probably could not fail of their mifchievous effect. As by laying a trap or pit-fall for another, whereby he is killed; letting out a wild beaft, with an intent to do mifchief; or exciting a madman to commit murder, fo that death thereupon enfues: in every one of thefe cafes the party offending is guilty of murder as a principal, in the firft degree. For he cannot be called an acceffory, that neceffarily pre-fuppofing a principal; and the poifon, the pit-fall, the beaft, or the madman, cannot be held principals, being only the inftruments of death. As therefore he muft be certainly guilty, either as principal or acceffory, and cannot be fo as acceffory, it follows that he muft be guilty as principal; and if principal, then in the firft degree; for there is no other criminal, much lefs a fuperior in the guilt, whom he could aid, abet, or affift.

Blackft. Comment. b. iv. c. 3.

PRINCIPAL *Point*, in perfpective, is a point in the perfpective plane, upon which a line is drawn from the eye, perpendicular to the plane falls.

This point is in the interfection of the horizontal and vertical plane; and is alfo called the *point of fight*, and *point of the eye*. See PERSPECTIVE.

PRINCIPAL *Ray*, in perfpective, is that which paffes perpendicularly from the fpectator's eye to the perfpective plane, or picture.

Whence the point where this ray falls on the plane, is by fome alfo called the *principal point*, which other writers call *the centre of the picture*, and *the point of concurrence*.

PRINCIPATO, the name of a province of Italy, in the kingdom of Naples, which is divided into two parts, called by the Italians the *Principato Ultra* and the *Principato Citra*, that is, the Hither and Farther Principato. The Hither Principato is bounded on the north by the Farther Principato and part of the Terra-di-Lavoro, on the weft and fouth by the Tufcan Sea, and on the eaft by the Bafilicata. It is about 60 miles in length, and 30 in breadth; the foil is fertile in wine, corn, oil, and faffron; and they have a great deal of filk, befides feveral mineral fprings. The capital town is Salerno. The Farther Principato is bounded on the north by the county of Molefe and the Terra-di-Lavoro, on the weft by the Tufcan Sea, on the fouth by the Hither Principato, and on the eaft by the Capitanata. It is about 37 miles in length, and 30 in breadth. The Apennine mountains render the air cold; and the foil is not very fertile either in corn or wine, but it produces chefnuts, and paftures in great plenty. Benevento is the capital town.

PRINCIPLE, PRINCIPIUM, in general, is ufed for the caufe, fource, or origin of any thing.

PRINCIPLE, in human nature. See DISPOSITION.

PRINCIPLE, in fcience, is a truth, admitted without proof, from which other truths are inferred by a chain of reafoning. Principles are of two kinds, *primary* and *general*; and to the laft the name of *axioms* is ufually given on account of their importance and *dignity*. An axiom or *general* principle, when the terms in which it is expreffed are underftood, muft be a felf-evident truth; but from its very nature it cannot be a *firft* truth. Our firft truths are all *particular*. A child knows that two *particular* lines, each an inch long, are equal to one another, before he has formed any *general* notions of length and equality. "Things equal to one and the fame thing are equal to one another," is the

first of Euclid's axioms; and an axiom it undoubtedly is, but to no man has it been a *firſt* truth. It is, if we may uſe the expreſſion, a *genus* or *claſs* of truths comprehending under it numberleſs individuals. Were a full-grown man introduced into the world, without a ſingle idea in his mind, as we may ſuppoſe Adam to have been, he would inſtantly perceive, upon laying together three pieces of wood each a foot long, that they were all equal in length; and if he were to cut another to the ſame length with *any one* of them, he would find upon trial, that it was of the ſame length with them all. After a few ſimple experiments of this kind, he would, by a law of human thought, infer that all things equal in length or in any other dimenſion, to any *one* thing, are in that dimenſion equal to one another.

It was not therefore with ſuch weakneſs as ſome have imagined, that Hobbes affirmed thoſe propoſitions commonly called axioms, not to be primary but ſecondary principles. A primary principle deſerves not the name of an axiom, as it is only a particular truth including in it no other truth. There is not one of Euclid's axioms which has not been the reſult of induction, though we remember not the time at which the induction was made. That the whole is greater than any of its parts is a general truth which no man of common ſenſe can controvert; but every one diſcovered that truth by obſerving that his body was larger than his head, his foot, or his hand; that a mountain is larger than a mole-hill in the middle of it; and that a piece of timber meaſuring what is called a yard is longer than any one of the diviſions marked upon it, and termed inches. The particular obſervations are made through the ſenſes and treaſured up in the memory; and the intellect, by its conſtitution, compares them together, marks in what they agree and diſagree, and thence draws its *axioms* or *general* principles. He, therefore, who ſhould admit the truth of an axiom, and deny the evidence of ſenſe and perception, would act as abſurdly as he who accepts payment in a bank-bill, and refuſes it in the individual pieces of gold or ſilver which that bill repreſents. General axioms are of infinite uſe in the purſuits of ſcience; but it is not becauſe they create new truths; they only ſhorten the proceſs in the diſcovery of ſuch as might be found, with labour, through the medium of particular propoſitions. See *Campbell's Philoſophy of Rhetoric* and *Tatham's Chart and Scale of Truth.*

Principles, in phyſics, are often confounded with elements, or the firſt and ſimpleſt parts whereof natural bodies are compounded, and into which they are again reſolvable by the force of fire.

PRINGLE (Sir John), an eminent phyſician and philoſopher, was a younger ſon of Sir John Pringle of Stitchel, in the ſhire of Roxburgh, Baronet; took the degree of M. D. at Leyden, 1730; and publiſhed there *Diſſertatio Inauguralis de Marcore Senili*, 4to. After having been ſome years profeſſor of moral philoſophy at Edinburgh, he was in June 1745 appointed phyſician to the duke of Cumberland, and phyſician-general to the hoſpital of the forces in Flanders, where the earl of Stair appears to have been his patron. In February 1746, Dr Pringle, Dr Armſtrong, and Dr Barker, were nominated phyſicians to the hoſpital for lame, maimed, and ſick ſoldiers, behind Buckingham-houſe; and in April 1749, Dr Pringle was appointed phyſician in ordinary to the king. In 1750 he publiſhed "Obſervations on the Nature and Cure of Hoſpital and Gaol Fevers, in a Letter to Dr Mead," 8vo (reprinted in 1755); and in 1752 he favoured the public with the reſult of his long experience in an admirable treatiſe under the title of "Obſervations on the Diſorders of the Army in Camp and Garriſon," 8vo. On the 14th of April 1752, he married Charlotte, ſecond daughter of Dr Oliver, an eminent phyſician at Bath. In 1756 he was appointed jointly with Dr Wintringham (now Sir Clifton Wintringham, Bart.) phyſician to the hoſpital for the ſervice of the forces of Great Britain. After the acceſſion of his preſent majeſty, Dr Pringle was appointed phyſician to the queen's houſehold, 1761; phyſician in ordinary to the queen in 1763, in which year he was admitted of the college of phyſicians in London; and on the 5th of June 1766, he was advanced to the dignity of a baronet of Great Britain. In 1772 he was elected preſident of the Royal Society, where his ſpeeches for five ſucceſſive years, on delivering the prize-medal of Sir Godfrey Copley, gave the greateſt ſatisfaction. Sir John Pringle in 1777 was appointed phyſician-extraordinary to the king. He was alſo a fellow of the College of Phyſicians at Edinburgh, and of the Royal Medical Society at Paris; member of the Royal Academies at Paris, Stockholm, Gottingen, and of the Philoſophical Societies at Edinburgh and Haerlem; and continued preſident of the Royal Society till November 1778; after which period he gradually withdrew from the world, and in 1781 quitted his elegant houſe in Pall Mall (where he had long diſtinguiſhed himſelf as the warm friend and patron of literary men of every nation and profeſſion), and made an excurſion to his native country. He returned to London in the latter end of that year; died greatly beloved and reſpected January 18. 1782; and having no children, was ſucceeded in eſtate, and alſo (agreeably to the limitation of the patent) in title, by his nephew, now Sir James Pringle, Bart. Among this worthy phyſician's communications to the Royal Society, the following are the principal: 1. "Some Experiments on Subſtances reſiſting Putrefaction," Phil. Tranſ. N° 495, p. 580; and N° 496, p. 525, 550; reprinted, with additions, in Martin's Abridgment, vol. xi. p. 1365. 2. "Account of ſome Perſons ſeized with the Gaol Fever by working in Newgate, and of the manner by which the Infection was communicated to one entire Family," vol. xlviii. p. 42. At the requeſt of Dr Hales, a copy of this uſeful paper was inſerted in the Gentleman's Magazine, 1753, p. 71, before its appearance in the Tranſactions. 3. "A remarkable Caſe of Fragility, Flexibility, and Diſſolution of the Bones," ib. p. 297. 4. "Account of the Earthquakes felt at Bruſſels," vol. xlix. p. 546. 5. "Account of ſinking of a River near Pontypool, in Monmouthſhire," ib. p. 547. 6. "Account of an Earthquake felt Feb. 18. 1756, along the coaſt of England, between Margate and Dover," ib. p. 579. 7. "Account of the Earthquake felt at Glaſgow and Dumbarton; alſo of a Shower of Duſt falling on a Ship between Shetland and Iceland," ib. p. 509. 8. "Several Accounts of the Fiery Meteor which appeared on Sunday, November 26. 1758, between eight and nine at night," vol. l. p. 218. 9. "Account of the Virtues

Prinos || Printing.

tues of Soap in dissolving the Stone, in the Case of the Reverend Mr Matthew Simson," ib. p. 221. 10. "Account of the Effects of Electricity in Paralytic Cases," ib. p. 481. And see a letter to him on that subject from Professor Winthorp. "Some Account of the Success of the *Vitrum Ceratum Antimonii*," was printed in the Edinburgh Medical Essays, vol. v.

PRINOS, in botany: A genus of the monogynia order, belonging to the hexandria class of plants; and in the natural method ranking under the 43d order, *Dumosæ*. The calyx is sexfid; the corolla monopetalous, and rotaceous; the belly hexaspermous.

PRINTER, a person who composes and takes impressions from moveable characters ranged in order, by means of ink, and a press.

PRINTING, the art of taking impressions from characters or figures, moveable and immoveable, on paper, linen, silk, &c. There are three kinds of printing: the one from moveable letters, for books; another from copper-plates, for pictures; and the last from blocks, in which the representation of birds, flowers, &c. are cut, for printing calicoes, linen, &c. The first is called *common* or *letter-press* printing; the second, *rolling-press* printing; and the last, *calico*, &c. printing. The principal difference between the three consists in this, that the first is cast in relievo, in distinct pieces; the second engraven in creux; and the third cut in relievo, and generally stamped, by placing the block upon the materials to be printed, and striking upon the back of it.

1 Letter-press printing.

Of the above branches, LETTER-PRESS PRINTING is the most curious, and deserves the most particular notice: for to it are owing chiefly our deliverance from ignorance and error, the progress of learning, the revival of the sciences, and numberless improvements in arts, which, without this noble invention, would have been either lost to mankind, or confined to the knowledge of a few. "To the art of printing (says an elegant essayist*), it is acknowledged we owe the reformation. It has been justly remarked, that if the books of Luther had been multiplied only by the slow process of the hand-writing, they must have been few, and would have been easily suppressed by the combination of wealth and power: but, poured forth in abundance from the press, they spread over the land with the rapidity of an inundation, which acquires additional force from the efforts used to obstruct its progress. He who undertook to prevent the dispersion of the books once issued from the press, attempted a task no less arduous than the destruction of the hydra. Resistance was vain, and religion was reformed: and we who are chiefly interested in this happy revolution must remember, amidst the praises bestowed on Luther, that his endeavours had been ineffectual, unassisted by the invention of Faustus.

2 Utility of this art.

* Dr Knox.

3 Good and evil resulting from it.

"How greatly the cause of religion has been promoted by the art, must appear, when it is considered, that it has placed those sacred books in the hand of every individual, which, besides that they were once locked up in a dead language, could not be procured without great difficulty. The numerous comments on them of every kind, which tend to promote piety, and to form the Christian philosopher, would probably never have been composed, and certainly would not have extended their beneficial influence, if typography had still been unknown. By that art, the light, which is to illuminate a dark world, has been placed in a situation more advantageous to the emission of its rays: but if it has been the means of illustrating the doctrines, and enforcing the practice of religion, it has also, particularly in the present age, struck at the root of piety and moral virtue, by propagating opinions favourable to the sceptic and the voluptuary. It has enabled modern authors wantonly to gratify their avarice, their vanity, and their misanthropy, in disseminating novel systems subversive of the dignity and happiness of human nature: but though the perversion of the art is lamentably remarkable in those volumes which issue, with offensive profusion, from the vain, the wicked, and the hungry, yet this good results from the evil, that as truth is great and will prevail, she must derive fresh lustre, by displaying the superiority of her strength in the conflict with sophistry.

"Thus the art of printing, in whatever light it is viewed, has deserved respect and attention. From the ingenuity of the contrivance, it has ever excited mechanical curiosity; from its intimate connection with learning, it has justly claimed historical notice; and from its extensive influence on morality, politics, and religion, it is now become a subject of very important speculation.

4 Its good effects overbalance the bad.

"But however we may felicitate mankind on the invention, there are perhaps those who wish, that, together with its compatriot art of manufacturing gunpowder, it had not yet been brought to light. Of its effects on literature, they assert, that it has increased the number of books, till they distract rather than improve the mind; and of its malignant influence on morals, they complain, that it has often introduced a false refinement, incompatible with the simplicity of primitive piety and genuine virtue. With respect to its literary ill consequences, it may be said, that though it produces to the world an infinite number of worthless publications, yet true wit and fine composition will still retain their value, and it will be an easy task for critical discernment to select these from the surrounding mass of absurdity: and though, with respect to its moral effects, a regard to truth extorts the confession, that it has diffused immorality and irreligion, divulged with cruel impertinence the secrets of private life, and spread the tale of scandal through an empire; yet these are evils which will either shrink away unobserved in the triumphs of time and truth over falsehood, or which may, at any time, be suppressed by legislative interposition."

5 History of the invention of printing.

Some writers have ascribed the origin of this art to the East, and affixed a very early period to its invention; particularly P. Jovius, (*Hist.* lib. xiv. p. 226. ed. Florent. 1550), from whom Osorius and many others have embraced the same opinion. But these have evidently confounded the European mode of printing with the *engraved tablets* which to this day are used in China. The invention of these tablets has been ascribed by many writers even to an earlier period than the commencement of the Christian era; but is with more probability assigned, by the very accurate Phil. Couplet, to the year 930. The *Historia Sinensis* of Abdalla, written in Persic in 1317, speaks of it as an art in very common use. MEERMAN, vol. i. p. 16. 218, 219, vol. ii. p. 186. N. Trigault asserts that the Chinese practised the art of

printing

printing five centuries before. Count Ferre Rezzonico found at Lyons plates with words and names engraven by a Nuremberger 1380.

The honour of having given rise to the European method has been claimed by the cities of *Harlem*, *Mentz*, and *Strasburg*. And to each of these it may be ascribed in a qualified sense, as they made improvements upon one another.

6
Claim of Harlem.

I. The first testimony of the inventor is that recorded by Hadrian Junius, in his *Batavia*, p. 253, ed. Lugd. Bat. 1588; which, though it hath been rejected by many, is of undoubted authority. Junius had the relation from two reputable men; Nicolaus Galius (A), who was his schoolmaster; and Quirinius Talesius, his intimate and correspondent. He ascribes it to LAURENTIUS, the son of John (Ædituus, or Custos, of the cathedral at HARLEM, at that time a respectable office), upon the testimony of Cornelius, some time a servant to Laurentius, and afterwards bookbinder to the cathedral, an office which had before been performed by Franciscan friars. His narrative was thus: "That, walking in a wood near the city (as the citizens of opulence use to do), he began at first to cut some letters upon the rind of a beech-tree; which, for fancy's sake, being impressed on paper, he printed one or two lines, as a specimen for his grand-children (the sons of his daughter) to follow. This having happily succeeded, he meditated greater things (as he was a man of ingenuity and judgment); and first of all, with his son-in-law Thomas Peter (who, by the way, left three sons, who all attained the consular dignity), invented a more glutinous writing-ink, because he found the common ink sunk and spread; and then formed whole pages of wood, with letters cut upon them; of which sort I have seen some essays, in an anonymous work, printed only on one side, intitled, *Speculum nostræ salutis*; in which it is remarkable, that in the infancy of printing (as nothing is complete at its first invention) the back sides of the pages were pasted together, that they might not by their nakedness betray their deformity. These beechen letters he afterwards changed for leaden ones, and these again for a mixture of tin and lead [*stanneas*] as a less flexible and more solid and durable substance. Of the remains of which types, when they were turned to waste metal, those old wine-pots were cast, that are still preserved in the family-house, which looks into the market-place, inhabited afterwards by his great-grandson Gerard Thomas, a gentleman of reputation; whom I mention for the honour of the family, and who died old a few years since. A new invention never fails to engage curiosity. And when a commodity never before seen excited purchasers, to the advantage of the inventor, the admiration of the art increased, dependents were enlarged, and workmen multiplied; the first calamitous incident! Among these was one John, whether, as we suspect, he had ominously the name of *Faustus* (B), unfaithful and unlucky to his master, or whether it was really a person of that name, I shall not much inquire; being unwilling to molest the silent shades, who suffer from a consciousness of their past actions in this life. This man, bound by oath to keep the secret of printing, when he thought he had learned the art of joining the letters, the method of casting the types, and other things of that nature, taking the most convenient time that was possible, on Christmas eve, when every one was customarily employed in lustral sacrifices, seizes the collection of types, and all the implements his master had got together, and, with one accomplice, marches off to Amsterdam, thence to Cologne, and at last settled at Mentz, as at an asylum of security, where he might go to work with the tools he had stolen. It is certain, that in a year's time, viz. in 1442, the *Doctrinale* of Alexander Galius, which was a grammar much used at that time, together with the *Tracts* of Peter of Spain, came forth there, from the same types as Laurentius had made use of at Harlem."

Thus far the narrative of Junius, which he had frequently heard from Nicolaus Galius; to whom it was related by Cornelius himself, who lived to a great age, and used to burst into tears upon reflecting on the loss his master had sustained, not only in his substance, but in his honour, by the roguery of his servant, his former associate and bedfellow. Cornelius, as appears by the registers of Harlem cathedral, died either in 1515, or the beginning of the following year; so that he might very well give this information to Nicolaus Galius, who was schoolmaster to Hadrian Junius.

Though this circumstance is probable as to the main fact, yet we must set aside the evidence of it in some particulars. 1. The first obvious difficulty is noticed by Scriverius; "that the types are said to be made of the *rind* of beach, which could not be strong enough to bear the impression of the press:" though this is removed, if, instead of the *bark*, we substitute a *bough* of the beach. The idea of the *bark*, when Junius wrote this, was perhaps strong in his mind, from what Virgil tells us (Ecl. v. 13.) of its being usual to cut words on the *bark* of a beech; and thence he was easily led to make a wrong application of it here.

Bower and Nichols's Origin of Printing.

2. The letters were at first *wooden*, and are said to be afterwards exchanged for *metal* types; from which the wine-pots were formed, remaining in the time of Junius. According to tradition, printing was carried on in the same house long after the time of Laurentius: these pots might therefore be formed from the waste metal of the printing-house, after the use of *fusile types* became universal.—But Laurentius seems to have carried the art no farther than *separate wooden types*. What is a remarkable

(A) Galius seems to be the same who is called *Claes Lottynsz. Gael*, Scabinus Harlemi, as it is in the Fasti of that city, in the years 1531, 1533, and 1535. Quirinius in the same Fasti is called *Mr Quiryn Dirksz̄oon.* He was many years amanuensis to the great Erasmus, as appears from his epistle, 23d July 1529. tom. iii. Oper. p. 1222. He was afterwards Scabinus in 1537 & seq. and Consul in 1552 & seq. But in the troubles of Holland he was cruelly killed by the Spanish soldiers, May 23. 1573. There are some letters of Hadrian Junius to this Talesius, in the *Epistolæ Junianæ*, p. 198.

(B) *John Faust*, or *Fust*, is by many supposed to have derived his name from *faustus*, "happy;" and Dr Faustus seems to carry an air of grandeur in the appellation: but very erroneously. *John Faust*, or *Fust*, is no more than *John Hand*, whence our name *Fist*.

Printing.

remarkable confirmation of this, Henry Spiechel, who wrote, in the 16th century, a Dutch poem intitled *Hertspiegel*, expresses himself thus: "Thou first, Laurentius, to supply the defect of wooden tablets, adaptedst *wooden types*, and afterwards didst connect them with a thread, to imitate writing. A treacherous servant surreptitiously obtained the honour of the discovery. But truth itself, though destitute of common and wide-spread fame; truth, I say, still remains." No mention in the poem of *metal types*; a circumstance which, had he been robbed of such, as well as of *wooden* ones, would scarcely have been passed over in silence.

When Laurentius first devised his rough specimen of the art, can only be guessed at. He died in 1440, after having published the *Speculum Belgicum*, and two editions of *Donatus*, all with different *wooden types*; which it is probable (considering the difficulties he had to encounter, and the many artists whom he must necessarily have had occasion to consult) cost him some years to execute; so that the first essay might be about 1430, which nearly agrees with Petrus Scriverius, who says the invention was about 10 or 12 years before 1440. See LAURENTIUS.

3. What was the specimen he first diverted himself with in cutting, at the distance of three centuries, one would think impossible to be discovered. And yet Joh. Enschedius, a printer, thinks he was so happy as to find it, being an old parchment *Horarium*, printed on both sides, in eight pages, containing the Letters of the Alpbabet, the Lord's Prayer, the Apostles Creed, and three short prayers. And Mr Meerman having shown this to proper artists who were judges of these matters, they gave it as their opinion that it agreed exactly with the description of Junius. It is conformable to the first edition of the Dutch *Speculum Salvationis*, and the fragments of both *Donatus's* of Holland, both which are the works of the same Laurentius, and were preceded by this. In these types, which are certainly moveable, cut, and uneven, there is a rudeness which Mr Meerman has not observed in any other instances. There are no numbers to the pages, no signatures, no *direction-words*, no divisions at the end of the lines; on the contrary, a syllable divided in the middle is seen, thus, *sp iritū*, in p. 8. l. 2, 3. There are neither distinctions nor points, which are seen in the other works of Laurentius; and the letter *i* is not marked with an accent, but with a dot at the top. The lines throughout are uneven. The shape of the pages not always the same; not (as they should be) rectangular, but sometimes rhomb-like, sometimes an *isoscele trapezium*; and the performance seems to be left as a specimen both of his piety, and of his ingenuity in this essay of a new invented art. Mr Meerman has given an exact engraving of this singular curiosity.

But, whatever else may appear doubtful in the narrative of Junius, it is very clear, that the first essays of the art are to be attributed to Laurentius, who used only *separate wooden types*. See the article LAURENTIUS.

7
Claim of Mentz.

II. Some of Laurentius's types were stolen from him by one of his servants (c), *John GEINSFLEICH senior*; who fled therewith to MENTZ. Having introduced the

(c) Authors differ as to the person who committed this robbery. It is clear from all accounts that his name was *John*; but what his surname was is the disputed point. Junius, after some hesitation, ascribes it to John Fust; but with injustice: for he was a wealthy man, who assisted the first printers at Mentz with money; and though he afterwards was proprietor of a printing-office, yet he never, as far as appears, performed any part of the business with his own hands, and consequently he could never have been a servant to Laurentius. Nor is the conjecture of Scriverius better founded, which fixes it upon John Gutenberg, who (as appears by authentic testimonies) resided at Strasburg from 1436 to 1444, and during all that period employed much fruitless labour and expence in endeavouring to attain this art. Mr Meerman once thought, "it might be either John Meidenbachius, (who, we are told by Seb. Munster and the author of *Chronographia Moguntinensis*, was an assistant to the first Mentz printers); or John Petersheimius (who was some time a servant to Fust and Schoeffer, and set up a printing-house at Francfort in 1459): or, lastly, some other person, who, being unable through poverty to carry on the business, discovered it to *Geinsfleich* at Mentz." But more authentic intelligence afterwards convinced him there were two persons of this name; and that John Geinsfleich senior * was the dishonest servant, who was born at Mentz, and who in the papers published by Kohlerus, we find there in the year 1441, and not before: for though he was of a good family, yet he was poor, and seems to have been obliged, as well as his brother, to seek his livelihood in a foreign country; and perhaps was content to be under Laurentius, that, when he had learned the art, he might follow it in his own. But, to leave conjecture, we may produce some certain testimonies.

1. It is what Junius himself says, that the person who stole the types did it with a view to set up elsewhere; nor is it likely that he would either make no use of an art he had seen so profitable to Laurentius, or that he would teach it to another and submit to be again a servant.

2. The Lambeth Record (which is printed below, from Mr Atkyns) tells us, that "Mentz gained the art by the brother of one of the workmen of Harlem, who learned it at home of his brother, who after set up for himself at Mentz."— By the strictest examination of the best authorities, it is plain, that by these *two brothers* the two Geinsfleiches must be meant. But as the younger (*Gutenberg*) was never a servant to Laurentius, it must be the senior who carried off the types, and instructed his brother in the art; who first applied himself to the business at Strasburg, and afterwards joined his elder brother, who had in the mean time settled at Mentz.

* He was called *Geinsfleich* κατ' ἐξοχὴν; the other was distinguished by the name of *Gutenberg*. They were both poor; though of a family distinguished by knighthood. They were both married men; and were most probably brothers, as it was not uncommon in that age for two brothers to have the same Christian name. These both appear in a disreputable light. The eldest robbed his master, with many aggravating circumstances. The youngest was remarkably contentious; and, after entering into a contract of marriage with Anna, a noble girl of *The Iron Gate*, refused to marry her till compelled by a judicial decree; and afterwards cared not what became of the lady, but left her behind at Strasburg when he removed to Mentz. He had not only frequent quarrels with his wife; but with *Andrew Drizehen*, *Andrew Heilmann*, and *John Riff*, all of whom were associated with him at Strasburg in his different employments of making of looking glasses, polishing of precious stones, and endeavouring to attain the art of printing: and with these he involved himself in three law-suits. See *Meerman*, vol. i. p. 163, &c. N.

What

the art from Harlem into this his native city, he set with all diligence to carry it on; and published, in 1442, *Alexandri Galli Doctrinale*, and *Petri Hispani Tractatus*; two works, which, being small, best suited his circumstances; and for which, being much used in the schools, he might reasonably expect a profitable sale. They were executed with *wooden types*, cut after the model of those he had stolen.

In 1443 he hired the house Zum Jungen; and was assisted with money by Fust, a wealthy person, who in return had a share of the business: and about the same time *John Meidenbachius* was admitted a partner, as were some others whose names are not transmitted to our times; and in 1444 they were joined by Gutenberg, who for that purpose quitted Strasburg. Wooden types being found not sufficiently durable, and not answering expectation in other respects, the two brothers first invented *cut metal types*. But while these were preparing, which must have been a work of time, several works were printed, both on *wooden separate types* and on *wooden blocks*; which were well adapted to small books of frequent use, such as the *Tabula Alphabetica*, the *Catholicon*, *Donati Grammatica*, and the *Confessionalia*.

From the above-mentioned printers in conjunction, after many smaller essays, the Bible was published in 1450, with *large cut metal types* (D). And it is no wonder, considering the immense labour this work cost, that it should be seven or eight years in completing. In this same year the partnership was dissolved, and a new one entered into, in August, between *Fust and Gutenberg*; the former supplying the money, the latter skill, for their common benefit. Various difficulties arising, occasioned a law-suit for the money which Fust had advanced; which was determined against Gutenberg. A dissolution of this partnership ensued in 1455; and in 1457 a magnificent edition of the Psalter was published by *Fust and Schoeffer*, with a remarkable commendation, in which they assumed to themselves the merit of a new invention, (viz of *metal types*), *ad inventionem artificiosam imprimendi ac characterizandi*. This book was uncommonly elegant, and in some measure the work of Gutenberg; as it was four years in the press, and came out but 18 months after the partnership was dissolved between him and Fust.

The latter continued in possession of the printing-office: and *Gutenberg*, by the pecuniary assistance of Conrad Humery syndic of Mentz (E), and others, opened another office in the same city; whence appeared, in 1460, without the printer's name, the *Catholicon Jo. de Janua*, with a pompous colophon in praise of its beauty, and ascribing the honour of the invention to the city of Mentz. It was a very handsome book, though inferior to the Psalter which had been published in 1457 by Fust and Schoeffer. Both the Psalter and *Catholicon* were printed on *cut metal types* (F). It may not be improper to observe here, that as the Psalter is the earliest book which is known to have a genuine date, it became a common practice, after that publication, for printers to claim their own performances, by adding their names to them.

III. The progress of the art has been thus traced through

What is still stronger, two chronologers of Strasburg, the one named *Dan Speklinus*, the other anonymous (in Meerman's *Documenta*, n° LXXXV. LXXXVI.), tells us expresly, that John Geinsfleich (viz. the senior, whom they distinguished from Gutenberg), having learned the art by being servant to its *first inventor*, carried it by theft into Mentz his native country. They are right in the fact, though mistaken in the application of it; for they make Strasburg the place of the invention, and Mentelius the inventor, from whom the types were stolen. But this is plainly an error: for Geinsfleich lived at Mentz in 1441, as appears from undoubted testimonies; and could not be a servant to Mentelius, to whom the before mentioned writers ascribe the invention in 1440, though more ancient ones do not attempt to prove that he began to print before 1444 or 1447. Nor will the narrative agree better with Gutenberg, who was an earlier printer than Mentelius; since, among the evidences produced by him in his law-suit, 1439, no Geinsfleich senior appears, nor any other servant but Laurentius Beildek. The narration therefore of the theft of Geinsfleich, being spread by various reports through the world, and subsisting in the time of these chronologers, was applied by them (to serve the cause they wrote for) to Strasburg; but serves to confirm the truth, since no writer derives the printing spoils from any other country than Holland or Alsatia. The chronologers have likewise, instead of Fust, called Gutenberg the wealthy man; who, from all circumstances, appears to have been poor. They also call Schoeffer the son-in-law of Mentelius; when it is clear that he married the daughter of Fust.

(D) Many writers have supposed that this was the edition of which some copies were sold in France, by Fust, as manuscripts, for the great price of 500 or 600 crowns, which he afterwards lowered to 60, and at last to less than 40. But it was the second and more expensive edition of 1462, that was thus disposed of, when Fust went to Paris in 1466, and which had cost 4000 florins before the third *quaternion* (or quire of four sheets) was printed. Meerman, vol. I. p. 6. 151, 152.

(E) At the death of Gutenberg, Conrad Humery took possession of all his printing materials; and engaged to the archbishop Adolphus, that he never would sell them to any one but a citizen of Mentz. They were, however, soon disposed of to Nicholas Bechtermuntze of Altavilla, who, in 1469, published *Vocabularium Latino-Teutonicum*, which was printed with the same types which had been used in the *Catholicon*. This very curious and scarce *Vocabulary* was shown to Mr Meerman, by Mr Bryant, in the Duke of Marlborough's valuable library at Blenheim. It is in quarto, 35 lines long, contains many extracts from the *Catholicon*, and is called *Ex quo*, from the preface beginning with those words. Meerman, vol. II. p. 96.

(F) Gutenberg never used any other than either *wooden* or *cut metal types* till the year 1462. In 1465 he was admitted *inter Aulicos* by the elector Adolphus, with an annual pension; and died in February 1468. His elder brother Geinsfleich died in 1462. Their epitaphs are printed by Mr Meerman, vol. II. p. 154, 295.

Printing.

8 Invention of cast types.

through its *second* period, the invention of *cut metal types*. But the honour of completing the discovery is due to Peter Schoeffer (g) de Gernsheim.

A very clear account of this final completion of the types is preserved by Trithemius (h). *Post hæc inventis successerunt subtiliora, inveneruntque modum* fundendi formas *omnium Latini alphabeti literarum, quas ipsi* matrices *nominabant: ex quibus rursum æneos sive stanneos characteres fundebant, ad omnem pressuram sufficientes, quos prius manibus sculpebant. Et revera sicuti* ante *xxx* ferme annos *ex ore Petri Opilionis de Gernsheim, civis Moguntini, qui gener erat primi artis inventoris, audivi, magnam a primo inventionis suæ hæc ars impressoria habuit difficultatem.—Petrus autem memoratus Opilio, tunc famulus postea gener, sicut diximus, inventoris primi, Johannis Fust, homo ingeniosus et prudens, faciliorem modum* fundendi characteres *excogitavit, et artem, ut nunc est, complevit.*

Another ample testimony in favour of Schoeffer is given by Jo. Frid. Faustus of Aschaffenburg, from papers preserved in his family: "Peter Schoeffer of Gernsheim, perceiving his master Fust's design, and being himself ardently desirous to improve the art, found out (by the good providence of God) the method of cutting *(incidendi)* the characters in a *matrix*, that the letters might easily be singly *cast*, instead of being *cut*. He privately *cut matrices* for the whole alphabet; and when he showed his master the letters cast from these matrices, Fust was so pleased with the contrivance, that he promised Peter to give him his only daughter, Christina, in marriage; a promise which he soon after performed. But there were as many difficulties at first with these letters, as there had been before with *wooden* ones; the metal being too soft to support the force of the impression: but this defect was soon remedied, by mixing the metal with a substance which sufficiently hardened it (i)."

Fust and Schoeffer concealed this new improvement, by administering an oath of secrecy to all whom they intrusted, till the year 1462; when, by the dispersion of their servants into different countries, at the sacking of Mentz by the archbishop Adolphus, the invention was publicly divulged.

The first book printed with these *improved types* was *Durandi Rationale*, in 1459; at which time, however, they seem to have had only *one size* of *cast* letters, all the larger characters which occur being *cut types*, as appears plainly by an inspection of the book. From this time to 1466, Fust and Schoeffer continued to print a considerable number of books; particularly two famous editions of *Tully's Offices*. In their earliest books, they printed more copies on *vellum* than on *paper*, which was the case both of their *Bibles* and *Tully's Offices*. This, however, was soon inverted; and *paper* introduced for the greatest part of their impressions; a few only being printed on *vellum* for curiosities, and for the purpose of being *illuminated*. How long Fust lived, is uncertain; but in 1471 we find Schoeffer was in partnership with *Conrad Henlif* and a kinsman of his master Fust. He published many books after the death of his father-in-law; the last of which that can be discovered is a third edition of the *Psalter* in 1490, in which the old *cut* types of the first edition were used.

Printing

9 Claim of Strasburg.

IV. With regard to the claim of STRASBURG: It has been already mentioned, that Gutenberg was engaged in that city in different employments; and, among others, in endeavouring to attain the art of printing. That these endeavours were unsuccessful, is plain from an authentic judicial decree of the senate of Strasburg in 1439, after the death of Andrew Drizehen (k).

But there are many other proofs that Gutenberg and his partners were never able to bring the art to perfection.

1. Wimphelingius*, the oldest writer in favour of Strasburg, tells us, that Gutenberg was the inventor of "a new art of writing," *ars impressoria*, which might also be called a *divine benefit*, and which he happily completed at Mentz; but does not mention one book of his printing: though he adds, that Mentelius printed many volumes correctly and beautifully, and acquired great wealth; whence we may conclude that he perfected what Gutenberg had in vain essayed.

2. Wimphelingius, in another book†, tells us, the art of printing was found out by Gutenberg *incomplete*; which implies, not that he practised the art in an imperfect manner (as Laurentius had done at Harlem), but rather that he had not been able to accomplish what he aimed at.

3. Gutenberg, when he left Strasburg in 1444 or the

* *Epitome Rerum Germanicarum* ed Argent. 1505, Meerman vol. i. p. 202. vol. ii. p. 139.

† *Catal. Episc.* Argent. 1508, *Meerman* ut supra.

(g) In German, Schoeffer; in Latin, *Opilio*; in English, *Shepherd*.——He is supposed by Mr Meerman to have been the first engraver on copperplates.

(h) *Annales Hirsaugienses*, tom. ii. ad ann. 1450.—As this book was finished in 1514, and Trithemius tells us he had the narrative from Schoeffer himself about 30 years before; this will bring us back to 1484, when Schoeffer must have been advanced in years, and Trithemius about 22 years old, who died in 1516. See *Voss*. Hist. Lat. l. 1. c. 10. *Fabr*. Med. & Infim. Æt. l. 9.

(i) See *Meerman*, vol. I. 9. 183. who copied this testimony from Wolfius, *Monument. Typograph.* vol. i. p. 468. seq.

(k) Their first attempts were made about 1436 with *wooden types*. Mr Meerman is of opinion that Geinsfleich junior (who was of an enterprising genius, and had already engaged in a variety of projects) gained some little insight into the business by visiting his brother who was employed by Laurentius at Haerleim, but not sufficient to enable him to practise it. It is certain that, at the time of the law-suit in 1439, much money had been expended, without any profit having arisen; and the unfortunate Drizehen, in 1438, on his death-bed, lamented to his confessor, that he had been at great expence, without having been reimbursed a single *obolus*. Nor did Gutenberg (who persisted in his fruitless endeavours) reap any advantage from them; for, when he quitted Strasburg, he was overwhelmed in debt, and under a necessity of selling every thing he was in possession of. [Meerman, vol. I. p. 198—202.] All the depositions in the law-suit above-mentioned (with the judicial decree) are printed by Mr Meerman, vol. II. p. 58—88. N.

the following year, and entered into partnership with Geinsfleich senior and others, had occasion for his brother's assistance to enable him to complete the art; which shows that his former attempts at Strasburg had been unsuccessful ‡.

4. These particulars are remarkably confirmed by Trithemius, who tells us, in two different places ||, that Gutenberg spent all his substance in quest of this art; and met with such insuperable difficulties, that, in despair, he had nearly given up all hopes of attaining it, till he was assisted by the liberality of Fust, and by his brother's skill, in the city of Mentz.

5. Ulric Zell says * the art was completed at Mentz; but that some books had been published in Holland earlier than in that city. Is it likely that Zell, who was a German, would have omitted to mention Strasburg, if it had preceded Mentz in printing?

There is little doubt therefore that all Gutenberg's labours at Strasburg amounted to no more than a fruitless attempt, which he was at last under the necessity of relinquishing: and there is no certain proof of a single book having been printed in that city till after the dispersion of the printers in 1462, when Mentelius and Eggestenius successfully pursued the business.

In fine, the pretensions of *Strasburg* fall evidently to be set aside. And as to the other two cities, *Harlem* and *Mentz*, the disputes between them seem easily cleared up, from the twofold invention of printing abovementioned: the first with *separate* WOODEN *types* at Harlem, by Laurentius, about 1430, and after continued by his family; the other with METAL *types*, first *cut*, and afterwards *cast*, which were invented at Mentz, but not used in Holland till brought thither by Theodoric Martens at Aloft about 1472.

From this period printing made a rapid progress in most of the principal towns of Europe. In 1490, it reached Constantinople; and, according to Mr Palmer, p. 281, &c. it was extended, by the middle of the next century, to Africa and America. It was introduced into Russia about 1560: but, from motives either of policy or superstition, it was speedily suppressed by the ruling powers; and, even under the present enlightened empress, has scarcely emerged from its obscurity.—That it was early practised in the inhospitable regions of Iceland, we have the respectable authority of Mr Bryant: "Arngrim Jonas was born amidst the snows of Iceland; yet as much prejudiced in favour of his country as those who are natives of an happier climate. This is visible in his *Crymogæa*; but more particularly in his *Anatome Blefkiniana*. I have in my possession this curious little treatise, written in Latin by him in his own country, and printed *Typis Holensibus in Islandiâ Boreali, anno* 1612. *Hola* is placed in some maps within the Arctic circle, and is certainly not far removed from it. I believe it is the farthest north of any place where arts and sciences have ever resided." *Observations and Inquiries relating to various parts of Ancient History*, 1767, p. 277.

It was a constant opinion, delivered down by our historians, as hath been observed by Dr Middleton, that the Art of Printing was introduced and first practised in England by *William Caxton*, a mercer and citizen of London; who, by his travels abroad, and a residence of many years in Holland, Flanders, and Germany, in the affairs of trade, had an opportunity of informing himself of the whole method and process of the art; and by the encouragement of the great, and particularly of the abbot of Westminster, first set up a press in that abbey, and began to print books soon after the year 1471.

Printing.

This was the tradition of our writers; till a book, which had scarce been observed before the Restoration, was then taken notice of by the curious, with a date of its impression from Oxford, *anno* 1468, and was considered immediately as a clear proof and monument of the exercise of printing in that university several years before Caxton began to deal in it.

This book, which is in the public library at Cambridge, is a small volume of 41 leaves in 4to, with this title: *Expositio Sancti Jeronimi in Simbolum Apostolorum ad Papam Laurentium*: and at the end, *Explicit expositio, &c. Impressa Oxonie, & finita Anno Domini* M.CCCC.LXVIII. XVII *die Decembris*.

11
The first printing-press set up in England was at Oxford.

The appearance of this book has robbed Caxton of a glory that he had long possessed, of being the author of printing in this kingdom; and Oxford has ever since carried the honour of the first press. The only difficulty was, to account for the silence of history in an event so memorable, and the want of any memorial in the university itself concerning the establishment of a new art amongst them of such use and benefit to learning. But this likewise has been cleared up by the discovery of a record, which had lain obscure and unknown at Lambeth-palace, in the Register of the See of Canterbury; and gives a narrative of the whole transaction, drawn up at the very time.

An account of this record was first published in a thin quarto volume, in English; with this title: "The Original and Growth of Printing, collected out of History and the Records of this Kingdome: wherein is also demonstrated, that Printing appertaineth to the Prerogative Royal, and is a Flower of the Crown of England. By Richard Atkyns, esq.—Whitehall, April the 25. 1664. By order and appointment of the right honourable Mr Secretary Morrice, let this be printed. Tho. Rycaut. London: Printed by John Streater, for the Author. 1664." 4to.

It sets forth in short, "That as soon as the art of printing made some noise in Europe, Thomas Bourchier, archbishop of Canterbury, moved the then king (Henry VI.) to use all possible means for procuring a printing-mould (for so it was then called) to be brought into this kingdom. The king (a good man, and much given to works of this nature) readily hearkened to the motion; and, taking private advice how to effect his design, concluded it could not be brought about without great secrecy, and a considerable sum of money given to such person or persons as would draw off some of the workmen of Harlem in Holland, where John Gutenberg had newly invented it, and was himself personally at work. It was resolved, that less than 1000 merks would not produce the desired effect; towards which sum the said archbishop presented the king 300 merks. The money being now prepared, the management of the design was committed to Mr Robert Turnour; who then was master of the robes to the king, and a person most in favour with him of any of his condition. Mr Turnour took to his assistance Mr Caxton, a citizen of good abilities, who traded much into Holland; which was a creditable pretence, as well for his going, as stay in the Low Countries. Mr Turnour was in disguise (his

Printing.

(his beard and hair ſhaven quite off); but Mr Caxton appeared known and public. They, having received the ſaid ſum of 1000 merks, went firſt to Amſterdam, then to Leyden, not daring to enter Harlem itſelf; for the town was very jealous, having impriſoned and apprehended divers perſons who came from other parts for the ſame purpoſe. They ſtaid till they had ſpent the whole thouſand merks in gifts and expences: ſo as the king was fain to ſend 500 merks more, Mr Turnour having written to the king that he had almoſt done his work; a bargain, as he ſaid, being ſtruck betwixt him and two Hollanders, for bringing off one of the underworkmen, whoſe name was Frederick Corſells (or rather Corſellis), who late one night ſtole from his fellows in diſguiſe into a veſſel prepared before for that purpoſe; and ſo, the wind favouring the deſign, brought him ſafe to London. It was not thought ſo prudent to ſet him on work at London: but, by the archbiſhop's means (who had been vice-chancellor and afterwards chancellor of the univerſity of Oxon) Corſellis was carried with a guard to Oxon; which guard conſtantly watched, to prevent Corſellis from any poſſible eſcape, till he had made good his promiſe in teaching them how to print. So that at Oxford printing was firſt ſet up in England, which was before there was any printing-preſs or printer in France, Spain, Italy, or Germany (except the city of Mentz), which claims ſeniority, as to printing, even of Harlem itſelf, calling her city, *Urbem Moguntinam artis typographicæ inventricem primam;* though it is known to be otherwiſe, that city gaining the art by the brother of one of the workmen of Harlem, who had learnt it at home of his brother, and after ſet up for himſelf at Mentz. This preſs at Oxon was at leaſt ten years before there was any printing in Europe, except at Harlem and Mentz, where it was but new-born. This preſs at Oxford was afterwards found inconvenient to be the ſole printing-place of England; as being too far from London and the ſea. Wherefore the king ſet up a preſs at St Alban's, and another in the city of Weſtminſter, where they printed ſeveral books of *divinity* and *phyſic: for the king* (for reaſons beſt known to himſelf and council) *permitted then no law-books to be printed;* nor did any printer exerciſe that art, but only ſuch as were the king's ſworn ſervants; *the king himſelf having the price and emolument for printing books.*—By this means the art grew ſo famous, that anno primo Richard III. c. 9. when an act of parliament was made for reſtraint of aliens for uſing any handicrafts here (except as ſervants to natives), a ſpecial proviſo was inſerted, that ſtrangers might bring in printed or written books to ſell at their pleaſure, and exerciſe the art of printing here, notwithſtanding that act: ſo that in the ſpace of 40 or 50 years, by the indulgence of Edward IV. Edward V. Richard III. Henry VII. and Henry VIII. the Engliſh proved ſo good proficients in printing, and grew ſo numerous, as to furniſh the kingdom with books; and ſo ſkilful, as to print them as well as any beyond the ſeas; as appears by the act 25 Hen. VIII. c. 15. which abrogates the ſaid proviſo for that reaſon. And it was further enacted in the ſaid ſtatute, that if any perſon bought foreign books bound, he ſhould pay 6s. 8d. *per* book. And it was further provided and enacted, that in caſe the ſaid printers or ſellers of books were unreaſonable in their prices, they ſhould be moderated by the lord chancellor, lord treaſurer, the two lords chief juſtices, or any two of them; who alſo had power to fine them 3s. 4d. for every book whoſe price ſhould be enhanced.—But when they were by charter corporated with *bookbinders, bookſellers,* and *founders of letters,* 3 & 4 Philip and Mary, and called *The Company of Stationers*—they kick'd againſt the power that gave them life, &c.—Queen Eliſabeth, the firſt year of her reign, grants by patent *the privilege of ſole printing all books that touch or concern the common laws of England,* to Tottel a ſervant to her majeſty, who kept it entire to his death; after him, to one Yeſt Weirt, another ſervant to her majeſty; after him, to Weight and Norton; and after them, king James grants the ſame privilege to More, one of the ſignet; which grant continues to this day, &c."

Printing.

When Caxton Corſellis was the firſt printer.

From the authority of this record, all our later writers declare Corſellis to be the firſt printer in England; Mr Anthony Wood, the learned Mr Maittaire, Palmer, and one John Bagford, an induſtrious man, who had publiſhed propoſals for an Hiſtory of Printing, (Phil. Tranſ. for April 1707). But Dr Middleton has called in queſtion the authenticity of this account, and has urged ſeveral objections to it, with the view of ſupporting Caxton's title to the precedency with reſpect to the introduction of the art into this country; of which we ſhall quote one or two, with the anſwers that have been made to them.

Objection 1.—"The ſilence of Caxton concerning a fact in which he is ſaid to be a principal actor, is a ſufficient confutation of it: for it was a conſtant cuſtom with him, in the prefaces or concluſions of his works, to give an hiſtorical account of all his labours and tranſactions, as far as they concerned the publiſhing and printing of books. And, what is ſtill ſtronger, in the continuation of the Polychronicon, compiled by himſelf, and carried down to the end of Henry the ſixth's reign, he makes no mention of the expedition in queſt of a printer: which he could not have omitted, had it been true; whilſt in the ſame book he takes notice of the invention and beginning of printing in the city of Mentz."

Anſwer.—As Caxton makes no mention in his Polychronicon of his *expedition in queſt of a printer;* ſo neither does he of his *bringing the art into England,* which it is as much a wonder he ſhould omit as the other. And as to his ſaying that *the invention of printing was at Mentz,* he means, of printing on *fuſile* ſeparate types. In this he copies, as many others have, from the *Faſciculus Temporum;* a work written in 1470, by Wernerus Rolevinch de Laer, a Carthuſian monk, a MS. copy of which was in the library of Gerard Jo. Voſſius (ſee lib. iii. *de Hiſtor. Latin.* c. 6.); and afterwards continued to the year 1474, when it was firſt printed at Cologne *typis Arnoldi ter Huernen.* It was republiſhed in 1481 by Heinricus Wirczburgh de Vach, a Cluniac monk, without mentioning the name either of the printer or of the place of publication. It is plain that Caxton had one at leaſt, or more probably both, of theſe editions before him, when he wrote his continuation of Polychronicon, as he mentions this work in his preface, and adopts the ſentiments of its editor. (See Meerman, vol. ii. p. 37. and his *Documenta,* N° VII. XXIV. and XXV.)

Obj. 2.—"There is a farther circumſtance in Caxton's hiſtory, that it ſeems inconſiſtent with the record; for we find him ſtill beyond ſea, about twelve years after the

the ſuppoſed tranſactions, " learning with great charge and trouble the art of printing" *(Recule of the Hiſtories of Troye,* in the end of the 2d and 3d books) ; which he might have done with eaſe at home, if he had got Corſellis into his hands, as the record imports, ſo many years before : but he probably learnt it at Cologne, where he reſided in 1471, (*Recule,* &c. ibid.), and whence books had been firſt printed with date the year before."

Anſ.—Caxton tells us, in the preface to *The Hiſtory of Troye,* that he began that tranſlation March 1. 1468, at Bruges ; that he proceeded on with it at Ghent ; that he finiſhed it at Cologne in 1471 ; and printed it, probably, in that city with his own types. He was 30 years abroad, chiefly in Holland ; and lived in the court of Margaret ducheſs of Burgundy, ſiſter of Edward IV. It was therefore much eaſier to print his book at Cologne, than to croſs the ſea to learn the art at Oxford. But further, there was a ſpecial occaſion for his printing it abroad. Corſellis had brought over ſo far the art of printing as he had learned it at Harlem, which was the method of printing on *wooden ſeparate* types, having the face of the letter cut upon them. But the art of *caſting* metal types being divulged in 1462 by the workmen of Mentz, Caxton thought proper to learn that advantageous branch before he returned to England. This method of caſting the types was ſuch an improvement, that they looked on it as the *original* of printing ; and Caxton, as moſt others do, aſcribes that to Mentz.—Caxton was an aſſiſtant with Turnour in getting off Corſellis ; but it is nowhere ſuppoſed that he came with him into England. (See MEERMAN, vol. ii. p. 34. B.)

Obj. 3.—" As the Lambeth record was *never heard of before the publication of Atkyn's book,* ſo it has never ſince been ſeen or produced by any man ; though the regiſters of Canterbury have on many occaſions been diligently and particularly ſearched for it. They were examined, without doubt, very carefully by archbiſhop Parker, for the compiling his *Antiquities of the Britiſh Church ;* where, in the life of Thomas Bourchier, tho' he congratulates that age on the noble and uſeful invention of printing, yet he is ſilent as to the introduction of it into England by the endeavours of that archbiſhop : nay, his giving the honour of the invention to Straſburg clearly ſhows that he knew nothing of the ſtory of Corſellis conveyed from Harlem, and that the record was not in being in his time. Palmer himſelf owns, " That it is not to be found there now ; for that the late earl of Pembroke aſſured him, that he had employed a perſon for ſome time to ſearch for it, but in vain :" (*Hiſt. of Printing,* p. 314.) On theſe grounds we may pronounce the record to be a forgery ; though all the writers above-mentioned take pains to ſupport its credit, and call it an *authentic piece.*

Atkyns, who by his manner of writing ſeems to have been *a bold and vain man,* might poſſibly be *the inventor:* for he had an intereſt in impoſing it upon the world, in order to confirm the argument of his book, that *printing was of the prerogative royal ;* in oppoſition to the *company of ſtationers,* with whom he was engaged in an expenſive ſuit of law, in defence of the *king's patents,* under which he claimed *ſome excluſive powers of printing.* For he tells us, p. 3. ' That, upon conſidering the thing, he could not but think that a public perſon, more eminent than a mercer, and a public purſe, muſt needs be concerned in ſo public a good : and the more he conſidered, the more inquiſitive he was to find out the truth. So that he had formed his hypotheſis before he had found his record ; which he publiſhed, he ſays, as a friend to truth ; not to ſuffer one man to be intitled to the worthy atchievements of another ; and as a friend to himſelf, not to loſe one of his beſt arguments of entitling the king to this art.' But, if Atkyns was not himſelf the contriver, he was impoſed upon at leaſt by ſome more crafty man ; who imagined that his intereſt in the cauſe, and the warmth that he ſhowed in proſecuting it, would induce him to ſwallow for genuine whatever was offered of the kind."

Anſ.—On the other hand, is it likely that Mr Atkyns would dare to *forge* a record, to be laid before the king and council, and which his adverſaries, with whom he was at law, could diſprove ?—(2.) He ſays he received this hiſtory from a perſon of honour, who was ſome time keeper of the Lambeth library. It was eaſy to have confuted this evidence, if it was falſe, when he publiſhed it, April 25. 1664.—(3.) John Bagford (who was born in England 1651, and might know Mr Atkyns, who died in 1677), in his Hiſtory of Printing at Oxford, blames thoſe who doubted of the authenticity of the Lambeth MS. ; and tells us that he knew Sir John Birkenhead had an authentic copy of it, when in 1665 [which Bagford by ſome miſtake calls 1664, and is followed in it by Meerman] he was appointed by the houſe of commons to draw up a bill relating to the exerciſe of that art. This is confirmed by the Journals of that houſe, Friday Oct. 27. 1665. vol. VIII. p. 622. where it is ordered, that this Sir John Birkenhead ſhould carry the bill on that head to the houſe of lords for their conſent.—The act was agreed to in the upper houſe on Tueſday Oct. 31. and received the royal aſſent on the ſame day ; immediately after which the parliament was prorogued. See *Journals of the Houſe of Lords,* Vol. XI. p. 700.—It is probable, then, that after Mr Atkyns had publiſhed his book in April 1664, the parliament thought proper, the next year, to inquire into *the right of the king's prerogative ;* and that Sir John Birkenhead took care to inſpect the original, then in the cuſtody of archbiſhop Sheldon : and, finding it not ſufficient to prove what Mr Atkyns had cited it for, made no report of the MS. to the houſe ; but only moved, that the former law ſhould be renewed. The MS. was probably never returned to the proper keeper of it ; but was afterwards burnt in the fire of London, Sept. 13. 1666.—(4.) That printing was practiſed at Oxford, was a prevailing opinion long before Atkyns. Bryan Twyne, in his *Apologia pro Antiquitate Academiæ Oxonienſis,* publiſhed 1608, tells us, it is ſo delivered down in *ancient writings ;* having heard, probably, of this Lambeth MS. And king Charles I. in his letters patent to the Univerſity of Oxford, March 5. in the eleventh of his reign, 1635, mentions printing as brought to *Oxford* from abroad. As to what is objected, " that it is not likely that the preſs ſhould undergo a ten or eleven years ſleep, viz. from 1468 to 1479," it is probably urged without foundation. Corſellis might print ſeveral books without date or name of the place, as Ulric Zell did at Cologne, from 1467 to 1473, and from that time to 1494. Corſellis's name, it may be ſaid, appears not in any of his publications ; but neither does that

Printing. that of Joannes Petershemius. [See MEERMAN, vol. I. p. 34.; vol. II. p. 21—27, &c.

Further, the famous Shakespeare, who was born in 1564, and died 1616, in the Second Part of Henry VI. act iv. sc. 7. introduces the rebel John Cade, thus upbraiding Lord Treasurer Say: "Thou hast most traiterously corrupted the youth of the realm, in creating a grammar-school: and whereas, before, our forefathers had no other book but the score and the tally, thou hast caused *Printing* to be used; and, contrary to the king, his crown, and dignity, thou hast built a paper-mill."— Whence now had Shakespeare this accusation against lord Say? We are told in the Poetical Register, vol. II. p. 231. ed. Lond. 1724, that it was from Fabian, Pol. Vergel, Hall, Hollingshed, Grafton, Stow, Speed, &c. But not one of these ascribes printing to the reign of Henry VI. On the contrary, Stow, in his Annals, printed at London 1560, p. 686, gives it expressly to William Caxton, 1471. "The noble science of printing was about this time found out in Germany at Magunce, by one John Guthumburgus a knight. One Conradus an Almaine brought it into Rome: William Caxton of London mercer, brought it into England about the year 1471, and first practised the same in the Abbie of St Peter at Westminster; after which time it was likewise practised in the Abbies of St Augustine at Canterburie, Saint Albons, and other monasteries of England." What then shall we say, that the above is an anachronism arbitrarily put into the mouth of an ignorant fellow out of Shakespeare's head? We might believe so, but that we have the record of Mr Atkyns confirming the same in king Charles II.'s time. Shall we say, that Mr Atkyns borrowed the story from Shakespeare, and published it with some improvements of money laid out by Henry VI. from whence it might be received by Charles II. as a prerogative of the crown? But this is improbable, since Shakespeare makes Lord Treasurer Say the instrument of importing it, of whom Mr Atkyns mentions not a word. Another difference there will still be between Shakespeare and the Lambeth MS.; the poet placing it before 1449, in which year Lord Say was beheaded; the MS. between 1454 and 1459, when Bourchier was archbishop. We must say, then, that lord Say first laid the scheme, and sent some one to Harlem, though without success; but after some years it was attempted happily by Bourchier. And we must conclude, that as the generality of writers have overlooked the invention of printing at Harlem with *wooden* types, and have ascribed it to Mentz where *metal* types were first made use of; so in England they have passed by Corsellis (or the first *Oxford Printer*, whoever he was, who printed with *wooden* types at Oxford), and only mentioned Caxton as the original artist who printed with *metal* types at Westminster. [See MEERMAN, vol. ii. 7, 8.] It is strange, that the learned commentators on our great dramatic poet, who are so minutely particular upon less important occasions, should every one of them, Dr Johnson excepted, pass by this curious passage, leaving it entirely unnoticed. And how has Dr Johnson trifled, by slightly remarking, "that Shakespeare is a little *too early* with this accusation!"—The great critic had undertaken to decipher obsolete words, and investigate unintelligible phrases; but never, perhaps, bestowed a thought on Caxton or Corsellis, on Mr Atkyns or the authenticity of the Lambeth Record.

But, independent of the record altogether, the book stands firm as a monument of the exercise of printing in Oxford six years older than any book of Caxton's with a date. In order to get clear of this strong fact Dr Middleton,

1. Supposes the date in question to have been falsified originally by the printer either by design or mistake; and an X to have been dropped or omitted in the age of its impression. Examples of this kind, he says, are common in the history of printing. And, "whilst I am now writing, an unexpected instance is fallen into my hands, to the support of my opinion; an *Inauguration Speech of the Woodwardian Professor, Mr Mason*, just fresh from the press, with its date given 10 years earlier than it should have been, by the omission of an x, viz. MDCCXXIV; and the very blunder exemplified in the last piece printed at Cambridge, which I suppose to have happened in the first from Oxford."——To this it has been very properly answered, That we should not pretend to set aside the authority of *a plain date*, without very strong and cogent reasons; and what the Doctor has in this case advanced will not appear, on examination, to carry that weight with it that he seems to imagine. There may be, and have been, mistakes and forgeries in the date both of books and of records too; but this is never allowed as a reason for suspecting such as bear no mark of either. We cannot from a blunder in the last book printed at Cambridge, infer a like blunder in the first book printed at Oxford. Besides, the *type* used in this our Oxford edition seems to be no small proof of its antiquity. It is the German letter, and very nearly the same with that used by Fust [who has been supposed to be] the first printer; whereas Caxton and Rood use a quite different letter, something between this German and our old English letter, which was soon after introduced by De Worde and Bynson.

2. "For the probability of his opinion (he says), the book itself affords sufficient proof: for, not to insist on what is less material, the *neatness of the letter, and regularity of the page*, &c. above those of Caxton, it has one mark, that seems to have carried the matter beyond probable, and to make it even certain, viz. *the use of signatures*, or letters of the alphabet placed at the bottom of the page, to show the sequel of the pages and leaves of each book; an improvement contrived for the direction of the bookbinders; which yet was not practised or invented at the time when this book is supposed to be printed; for we find no signatures in the books of Faust or Schoeffer at Mentz, nor in the improved or beautiful impressions of John de Spira and Jenson at Venice, till several years later. We have a book in our library, that seems to fix the very time of their invention, at least in Venice; the place where the art itself received the greatest improvements: *Baldi lectura super Codic. &c* printed by *John de Colonia* and *Jo. Manthem de Gherretzem, anno* MCCCCLXXIIII. It is a large and fair volume in folio, *without signatures*, till about the middle of the book, in which they are first introduced, and so continued forward: which makes it probable, that the first thought of them was suggested during the impression; for we have likewise *Lectura Bartholi super Codic.* &c. in two noble and beautiful volumes in folio, printed the

the year before at the same place, by Vindelin de Spira, without them: yet from this time forward they are generally found in all the works of the Venetian printers, and from them propagated to the other printers of Europe. They were used at (L) Cologne, in 1475; at Paris, 1476; by Caxton, not before 1480: but if the discovery had been brought into England, and practised at Oxford 12 years before, it is not probable that he would have printed so long at Westminster without them. Mr Palmer indeed tells us, p. 54, 180, that Anthony Zarot was esteemed the inventor of signatures; and that they are found in a Terence printed by him at Milan in the year 1470, in which he first printed. I have not seen that Terence; and can only say, that I have observed the want of them in some later works of this, as well as of other excellent printers of the same place. But, allowing them to be in the Terence, and Zarot the inventor, it confutes the date of our Oxford book as effectually as if they were of later origin at Venice; as I had reason to imagine, from the testimony of all the books that I have hitherto met with."—— As to these proofs, first, the neatness of the letter, and the regularity of the page, prove, if any thing, the very reverse of what the Doctor asserts. The art of printing was almost in its infancy brought to perfection; but afterwards debased by later printers, who consulted rather the cheapness than the neatness of their work. Our learned dissertator cannot be unacquainted with the labours of Fust and Jenson. He must know, that though other printers may have printed more correctly, yet scarce any excel them, either in the neatness of the letter, or the regularity of the page. The same may be observed in our English printers. Caxton and Rood were indifferently good printers; De Worde and Pynson were worse; and those that follow them most abominable. This our *anonymous Oxford printer* excels them all; and for this very reason we should judge him to be the most ancient of all. Our dissertator lays great stress on the use of signatures. But no certain conclusion can be drawn either from the use or non-use of these lesser improvements of printing. They have in different places come in use at different times, and have not been continued regularly even at the same places. If Anthony Zarot used them at Milan in 1470, it is certain later printers there did not follow his example; and the like might happen also in England. But, what is more full to our purpose, we have in the Bodleian library an Æsop's Fables printed by Caxton. This is, it is believed, the first book which has *the leaves numbered*. But yet this improvement, though more useful than that of the signatures, was disused both by Caxton himself and other later printers in England. It is therefore not at all surprising (if true) that the signatures, though invented by our Oxford printer, might not immediately come into general use. And consequently, this particular carries with it no such certain or effectual confutation as our dissertator boasts of.

Printing.

3. What the Doctor thinks farther confirms his opinion is, "That, from the time of the pretended date of this book, *anno* 1468, we have no other fruit or production from the press at Oxford for 11 years next following; and it cannot be imagined that a press, established with so much pains and expence, could be suffered to be so long idle and useless."—To this it may be answered, in the words of Oxonides, 1st, That his books may have been lost. Our first printers, in those days of ignorance, met with but small encouragement; they printed but few books, and but few copies of those books. In after-times, when the same books were reprinted more correctly, those first editions, which were not as yet become curiosities, were put to common uses. This is the reason that we have so few remains of our first printers. We have only four books of Theodoric Rood, who seems by his own verses to have been a very celebrated printer. Of John Lettou-William de Machlinia, and the schoolmaster of St Alban's, we have scarce any remains. If this be considered, it will not appear *impossible* that our printer should have followed his business from 1468 to 1479, and yet time have destroyed his intermediate works. But, 2dly, We may account still another way for this distance of time, without altering the date. The Civil Wars broke out in 1469: this might probably oblige our Oxford printer to shut up his press; and both himself and his readers be otherwise engaged. If this were the case, he might not return to his work again till 1479; and the next year, not meeting with that encouragement he deserved, he might remove to some other country with his types.

Dr Middleton concludes with apologizing for his "spending so much pains on an argument so inconsiderable, to which he was led by his zeal to do a piece of justice to the memory of our worthy countryman William Caxton; nor suffer him to be robbed of the glory, so clearly due to him, of having *first imported into this kingdom* an art of great use and benefit to mankind: a kind of merit that, in the sense of all nations, gives the best title to true praise, and the best claim to be commemorated with honour to posterity."

13
The real claims of Caxton and Corsellis respectively.

The fact, however, against which he contends, but which it seems impossible to overturn, does by no means derogate from the honour of Caxton, who, as has been shown, was the first person in England that practised the art of printing with *fusile types*, and consequently the first who brought it to perfection; whereas Corsellis printed with *separate cut types in wood*, being the only method which

(L) Dr Middleton is mistaken in the time and place of the invention of signatures. They are to be found even in very ancient MSS. which the earliest printers very studiously imitated; and they were even used in some editions from the office of Lawrence Coster (whence Corsellis came), which consisted of wooden cuts, as in *Figuræ typicæ et antitypicæ Novi Testamenti;* and in some editions with metal types, as in *Gosp. Pergamensis epistolæ*, published at Paris, without a date, but printed A. D. 1470, (Maittaire*, Annal. vol. i. p. 25.); and in *Mammetrectus*, printed by Helias de Llouffen, at Bern in Switzerland, 1470; and in *De Tondeli visione*, at Antwerp, 1472. Venice, therefore, was not the place where they were first introduced.—They began to be used in *Baldus*, it seems, when the book was half finished. The printer of that book might not know, or did not think, of the use of them before. See *Meerman*, vol. ii. p. 18.; and *Phil. Transf.* vol xxiii. n° 208. p. 1509.

* See *Maittaire.*

Printing. which he had learned at Harlem. Into this detail, therefore, we have been led, not ſo much by the importance of the queſtion, as on account of ſeveral anecdotes connected with it, which ſeemed equally calculated to ſatisfy curioſity and afford entertainment.

Caxton had been bred very reputably in the way of trade, and ſerved an apprenticeſhip to one Robert Large a mercer; who, after having been ſheriff and lord mayor of London, died in the year 1441, and left by will, as may be ſeen in the prerogative-office, XXIIII merks to his apprentice William Caxton: a conſiderable legacy in thoſe days, and an early teſtimonial of his good character and integrity.

From the time of his maſter's death, he ſpent the following thirty years beyond ſea in the buſineſs of merchandiſe: where, in the year 1464, we find him employed by Edward IV. in a public and honourable negociation, jointly with one Richard Whitehill, Eſq; to tranſact and conclude a treaty of commerce between the king and his brother-in-law the duke of Burgundy, to whom Flanders belonged. The commiſſion ſtyles them, *ambaſſiatores*, *procuratores*, *nuncios*, & *deputatos ſpeciales*; and gives to both or either of them full powers to treat, &c.

Whoever turns over his printed works, muſt contract a reſpect for him, and be convinced that he preſerved the ſame character through life, of an honeſt, modeſt, man; greatly induſtrious to do good to his country, to the beſt of his abilities, by ſpreading among the people ſuch books as he thought uſeful to religion and good manners, which were chiefly tranſlated from the French. The novelty and uſefulneſs of his art recommended him to the ſpecial notice and favour of the great; under whoſe protection, and at whoſe expence, the greateſt part of his works were publiſhed. Some of them are addreſſed to king Edward IV. his brother the duke of Clarence, and their ſiſter the ducheſs of Burgundy; in whoſe ſervice and pay he lived many years before he began to print, as he often acknowledges with great gratitude. He printed likewiſe for the uſe, and by the expreſs order, of Henry VII. his ſon prince Arthur, and many of the principal nobility and gentry of that age.

It has been generally aſſerted and believed, that all his books were printed in the abbey of Weſtminſter; yet we have no aſſurance of it from himſelf, nor any mention of the place before the year 1477: ſo that he had been printing ſeveral years without telling us where.

There is no clear account left of Caxton's age: but he was certainly very old, and probably above fourſcore, at the time of his death. In the year 1471 he complained of the infirmities of age creeping upon him, and feebling his body: yet he lived 23 years after, and purſued his buſineſs, with extraordinary diligence, in the abbey of Weſtminſter, till the year 1494, in which he died; not in the year following, as all who write of him affirm. This appears from ſome verſes at the end of a book, called "Hilton's Scale of Perfection," printed in the ſame year:

Infynite laud with thankynges many folde
I yield to God me ſocouryng with his grace
This boke to finyſhe which that ye beholde
Scale of Perfection calde in every place
Whereof th' auctor Walter Hilton was
And Wynkyn de Worde this hath ſett in print
In William Caxſtons hows ſo fyll the caſe,
God reſt his ſoule. In joy ther mot it ſtynt.
Impreſſus anno ſalutis MCCCCLXXXXIIII.

Though he had printed for the uſe of Edward IV. and Henry VII. yet there appears no ground for the notion which Palmer takes up, that the firſt printers, and particularly Caxton, were ſworn ſervants and printers to the crown; for Caxton, as far as can be obſerved, gives not the leaſt hint of any ſuch character or title; though it ſeems to have been inſtituted not long after his death; for of his two principal workmen, Richard Pynſon and Wynkyn de Worde, the one was made printer to the king, the other to the king's mother the Lady Margaret. Pynſon gives himſelf the firſt title, in *The imitation of the Life of Chriſt*; printed by him at the commandment of the Lady Margaret, who had tranſlated the fourth book of it from the French, in the year 1504: and Wynkyn de Worde aſſumes the ſecond, in *The ſeven Penitential Pſalms*, expounded by Biſhop Fiſher, and printed in the year 1509. But there is the title of a book given by Palmer, that ſeems to contradict what is here ſaid of Pynſon: viz. *Pſalterium ex mandato victorioſiſſimi Angliæ Regis Henrici Septimi, per GulielmumFanque, impreſſorem regium*, anno MDIIII; which being the only work that has ever been found of this printer, makes it probable that he died in the very year of its impreſſion, and was ſucceeded immediately by Richard Pynſon. No book hath yet been diſcovered printed in Scotland in this period, though the Engliſh printers were able to export ſome of their works to other countries. See Henry's *Hiſtory of Great Britain*, vol. v. p. 471.

Before 1465, the uniform character was the old *Gothic* or *German*; whence our *Black* was afterwards formed. But in that year an edition of Lactantius was printed in a kind of Semi-Gothic, of great elegance, and approaching nearly to the preſent *Roman* type; which laſt was firſt uſed at Rome in 1467, and ſoon after brought to great perfection in Italy, particularly by Jenſon.

Towards the end of the 5th century, Aldus invented the *Italic* character which is now in uſe, called, from his name, *Aldine* or *curſivus*. This ſort of letter he contrived, to prevent the great number of abbreviations that were then in uſe.

The firſt eſſays in Greek that can be diſcovered are a few ſentences which occur in the edition of Tully's *Offices*, 1465, at Mentz; but theſe were miſerably incorrect and barbarous, if we may judge from the ſpecimens Mr Maittaire has given us, of which the following is one:

Οτιcαταaxaρτμaxaτa xαι τατωτωxa.

In the ſame year, 1465, was publiſhed an edition of Lactantius's *Inſtitutes*, printed *in monaſterio Sublacenſi*, in the kingdom of Naples, in which the quotations from the Greek authors are printed in a very neat Greek letter. They ſeem to have had but *a very ſmall quantity* of Greek types in the monaſtery; for, in the firſt part of the work, whenever a long ſentence occurred, a blank was left, that it might be written in with a pen: after the middle of the work, however, all the Greek that occurs is printed.

The firſt printers who ſettled at Rome were Conrad Sweynheim and Arnold Pannartz, who introduced the preſent *Roman* type, in 1466, in Cicero's *Epiſtolæ Familiares:* in 1469 they printed a beautiful edition of *Aulus Gellius*, with the Greek quotations in a fair character, without accents or ſpirits, and with very few abbreviations.

The firſt whole book that is yet known is the Greek Grammar of Conſtantine Laſcaris, in quarto, reviſed by Demetrius Cretenſis, and printed by Dionyſius Palaviſinus, at Milan, 1476. In 1481, the Greek *Pſalter* was printed here, with a Latin tranſlation, in folio; as was Æſop's Fables in quarto.

Venice ſoon followed the example of Milan; and in 1486 were publiſhed in that city the *Greek Pſalter* and the *Batrachomyomachia*, the former by Alexander, and the latter by Laonicus, both natives of Crete. They were printed in a very uncommon character; the latter of them with *accents* and *ſpirits*, and alſo with *ſcholia*.

In 1488, however, all former publications in this language were eclipſed by a fine edition of *Homer's Works* at Florence, in folio, printed by Demetrius, a native of Crete. Thus printing (ſays Mr Maittaire, p. 185.) ſeems to have attained its ακμη of perfection, after having exhibited moſt beautiful ſpecimens of Latin, Greek, and Hebrew.

In 1493, a fine edition of *Iſocrates* was printed at Milan, in folio, by Henry German and Sebaſtian ex Pantremulo.

All the above works are prior in time to thoſe of Aldus, who has been erroneouſly ſuppoſed to be the *firſt* Greek printer: the beauty, however, correctneſs, and number of his editions, place him in a much higher rank than his predeceſſors; and his characters in general were more elegant than any before uſed. He was born in 1445, and died in 1515.

Though the noble Greek books of Aldus had raiſed an univerſal deſire of reviving that tongue, the French were backward in introducing it. The only pieces printed by them were ſome quotations, ſo wretchedly performed, that they were rather to be gueſſed at than read; in a character very rude and uncouth, and without accents. But Francis Tiſſard introduced the ſtudy of this language at Paris, by his Βιϐλος η γνωμαγυρικη, in 1507; and that branch of printing was afterwards ſucceſsfully practiſed by Henry, Robert, and Henry Stephens. See the article Stephens.

The earlieſt edition of the *whole Bible* was, ſtrictly ſpeaking, the Complutenſian Polyglott of Cardinal Ximenes; but as that edition, though finiſhed in 1517, was not publiſhed till 1522, the *Venetian* Septuagint of 1518 may properly be called the firſt edition of the *whole* Greek Bible; Eraſmus having publiſhed the New Teſtament *only* at Baſil in 1516.

A very ſatisfactory account of Hebrew printing is thus given by Dr Kennicott in his *Annual Accounts of the Collation of Hebrew MSS.* p. 112. "The method which ſeems to have been originally obſerved in printing the Hebrew Bible was juſt what might have been expected: 1. The Pentateuch in 1482. 2. The Prior Prophets, in 1484. 3. The Poſterior Prophets, in 1486. 4. The Hagiographa, in 1487. And, after the four great parts had been thus printed ſeparately (each with a comment), the whole text (without a comment) was printed in one volume in 1488; and the text continue to be printed, as in theſe firſt editions, ſo in ſeveral others for 20 or 30 years, without marginal *Keri* or *Maſora*, and with greater arguments to the more ancient MSS. till about the year 1520 ſome of the Jews adopted later MSS. and the *Maſora;* which abſurd preference has obtained ever ſince."

Thus much for the ancient editions given by Jews.

In 1642 a Hebrew Bible was printed at Mantua under the care of the moſt learned Jews in Italy. This Bible had not been heard of among the Chriſtians in this country, nor perhaps in any other; though the nature of it is very extraordinary. The text indeed is nearly the ſame with that in other modern editions; but at the bottom of each page are various readings, amounting in the whole to above 2000, and many of them of great conſequence, collected from manuſcripts, printed editions, copies of the Talmud, and the works of the moſt renowned Rabbies. And in one of the notes is this remark:—"That in ſeveral paſſages of the Hebrew Bible the differences are ſo many and ſo great, that they know not which to fix upon as the true readings."

We cannot quit this ſubject without obſerving, on Dr Kennicott's authority, that as the firſt printed Bibles are more correct than the latter ones; ſo the variations between the firſt edition, printed in 1488, and the edition of Vander Hooght, in 1705, at Amſterdam, in 2 vols 8vo, amount, upon the whole, to above 1200! See further *Bowyer and Nichols*, p. 112—117.

17 Anecdotes of early printing.

When the art of printing was firſt diſcovered, they only made uſe of one ſide of a page: they had not yet found out the expedient of impreſſing the other. When their editions were intended to be curious, they omitted to print the firſt letter of a chapter, for which they left a blank ſpace, that it might be painted or illuminated at the option of the purchaſer. Several ancient volumes of theſe early times have been found, where theſe letters are wanting, as they neglected to have them painted.

When the art of printing was firſt eſtabliſhed, it was the glory of the learned to be correctors of the preſs to the eminent printers. Phyſicians, lawyers, and biſhops themſelves, occupied this department. The printers then added frequently to their names thoſe of the correctors of the preſs; and editions were then valued acccording to the abilities of the corrector.

In the productions of early printing may be diſtinguiſhed the various ſplendid editions they made of *Primers* or *Prayer-books*. They were embelliſhed with cuts finiſhed in a moſt elegant taſte: many of them were ludicrous, and ſeveral were obſcene. In one of them an angel is repreſented crowning the Virgin Mary, and God the Father himſelf aſſiſting at the ceremony. We have ſeen in a book of natural hiſtory the Supreme Being repreſented as *reading* on the ſeventh day, when he reſted from all his works. Sometimes St Michael is ſeen overcoming Satan; and ſometimes St Anthony appears attacked by various devils of moſt hideous forms. The *Prymer of Saliſbury*, 1533, is full of cuts: at the bottom of the title page there is the following remarkable prayer:

God be in my Bede,
And in my Underſtandynge.
God be in my Eyen,
And in my Lokynge.

 God

Printing.

God be in my Mouthe,
And in my Spekynge.
God be in my Herte,
And in my thinkinge.
God be at myn ende,
And at my departynge.

18
Method of printing.

The workmen employed in the art of printing are of two kinds: compositors, who range and dispose the letters into words, lines, pages, &c. according to the copy delivered them by the author; and pressmen, who apply ink upon the same, and take off the impression. The types being cast, the compositor distributes each kind by itself among the divisions of two wooden frames, an upper and an under one, called *cases*; each of which is divided into little cells or boxes. Those of the upper case are in number 98: these are all of the same size; and in them are disposed the capitals, small capitals, accented letters, figures, &c. the capitals being placed in alphabetical order. In the cells of the lower case, which are 54, are placed the small letters, with the points, spaces, &c. The boxes are here of different sizes, the largest being for the letters most used; and these boxes are not in alphabetical order, but the cells which contain the letter oftenest wanted are nearest the compositor's hand. Each case is placed a little aslope, that the compositor may the more easily reach the upper boxes. The instrument in which the letters are set is called a *composing-stick* (n° 1.), which consists of a long and narrow plate of brass or iron, &c. on the right side of which arises a ledge, which runs the whole length of the plate, and serves to sustain the letters, the sides of which are to rest against it; along this ledge is a row of holes, which serve for introducing the screw *a*, in order to lengthen or shorten the extent of the line, by moving the sliders *b c* farther from or nearer to the shorter ledge at the end *d*. Where marginal notes are required in a work, the two sliding pieces *b c* are opened to a proper distance from each other in such a manner as that while the distance between *d c* forms the length of the line in the text, the distance between the two sliding-pieces forms the length of the lines for the notes on the side of the page. Before the compositor proceeds to compose, he puts a rule or thin slip of brass-plate, cut to the length of the line, and of the same height as the letter, in the composing-stick, against the ledge, for the letter to bear against. Things thus prepared, the compositor having the copy lying before him, and his stick in his left-hand, his thumb being over the slider *c*; with the right he takes up the letters, spaces, &c. one by one, and places them against the rule, while he supports them with his left thumb by pressing them to the end of the slider *c*, the other hand being constantly employed in setting in other letters: the whole being performed with a degree of expedition and address not easy to be imagined.

Plate CCCCXV.

A little being thus composed, if it end with a word or syllable, and exactly fill the measure, there needs no further care; otherwise, more spaces are to be put in, or else the distances lessened, between the several words, in order to make the measure quite full, so that every line may end even. The spaces here used are pieces of metal exactly shaped like the shanks of the letters: they are of various thicknesses, and serve to support the letters, and to preserve a proper distance between the words; but not reaching so high as the letters, they make no impression when the work is printed. The first line being thus finished, the compositor proceeds to the next; in order to which he moves the brass-rule from behind the former, and places it before it, and thus composes another line against it after the same manner as before; going on thus till his stick is full, when he empties all the lines contained in it into the gally.

The compositor then fills and empties his composing-stick as before, till a complete page be formed; when he ties it up with a cord or pack-thread; and setting it by, proceeds to the next, till the number of pages to be contained in a sheet is completed; which done, he carries them to the imposing-stone, there to be ranged in order, and fastened together in a frame called a *chase*; and this is termed *imposing*. The chase is a rectangular iron frame, of different dimensions according to the size of the paper to be printed, having two cross-pieces of the same metal, called a *long* and *short cross*, mortised at each end so as to be taken out occasionally. By the different situations of these crosses the chase is fitted for different volumes: for quartos and octavos, one traverses the middle lengthwise, the other broadwise, so as to intersect each other in the centre: for twelves and twenty-fours, the short cross is shifted nearer to one end of the chase; for folios, the long cross is left entirely out, and the short one left in the middle; and for broadsides, both crosses are set aside. To dress the chase, or range and fix the pages therein, the compositor makes use of a set of furniture, consisting of slips of wood of different dimensions, and about half an inch high, that they may be lower than the letters: some of these are placed at the top of the pages, and called *head-sticks*; others between them, to form the inner margin; others on the sides of the crosses, to form the outer margin, where the paper is to be doubled; and others in the form of wedges to the sides and bottoms of the pages. Thus all the pages being placed at their proper distances, and secured from being injured by the chase and furniture placed about them, they are all untied, and fastened together by driving small pieces of wood called *quoins*, cut in the wedge-form, up between the slanting side of the foot and the side sticks and the chase, by means of a piece of hard wood and a mallet; and all being thus bound fast together, so that none of the letters will fall out, it is ready to be committed to the pressmen. In this condition the work is called a *form*; and as there are two of these forms required for every sheet, when both sides are to be printed, it is necessary the distances between the pages in each form should be placed with such exactness, that the impression of the pages in one form shall fall exactly on the back of the pages of the other, which is called *register*.

As it is impossible but that there must be some mistakes in the work, either through the oversight of the compositor, or by the casual transposition of letters in the cases; a sheet is printed off, which is called a *proof*, and given to the corrector; who reading it over, and rectifying it by the copy, making the alterations in the margin, it is delivered back to the compositor to be corrected.

The compositor then unlocking the form upon the correcting-stone, by loosening the quoins or wedges which bound the letters together, rectifies the mistakes by

ting. by picking out the faulty or wrong letters with a ſlender ſharp-pointed ſteel-bodkin, and putting others into their places. After this another proof is made, ſent to to the author, and corrected as before; and laſtly, there is another proof called a *reviſe*, which is made in order to ſee whether all the miſtakes marked in the laſt proof are corrected.

The preſſman's buſineſs is to work off the forms thus prepared and corrected by the compoſitor; in doing which there are four things required, paper, ink, balls, and a preſs. To prepare the paper for uſe, it is to be firſt wetted by dipping ſeveral ſheets together in water: theſe are afterwards laid in a heap over each other; and to make them take the water equally, they are all preſſed cloſe down with a weight at the top. The ink is made of oil and lamp-black; for the manner of preparing which, ſee *Printing-Ink*. The balls, by which the ink is applied on the forms, are a kind of wooden funnels with handles, the cavities of which are filled with wool or hair, as is alſo a piece of alum leather or pelt nailed over the cavity, and made extremely ſoft by ſocking in urine and by being well rubbed. One of theſe the preſſman takes in each hand; and applying one of them to the ink-block, daubs and works them together to diſtribute the ink equally; and then blackens the form which is placed on the preſs, by beating with the balls upon the face of the letter.

Plate CCXV. The printing-preſs, repreſented nº 2. is a very curious though complex machine. The body conſiſts of two ſtrong cheeks *a a*, placed perpendicularly, and joined together by four croſs-pieces; the cap *b*; the head *c*, which is moveable, being partly ſuſtained by two iron pins or long bolts, that paſs the cap; the till or ſhelf *d d*, by which the ſpindle and its apparatus are kept in their proper poſition; and the winter *e*, which bears the carriage, and ſuſtains the effort of the preſs beneath. The ſpindle *f* is an upright piece of iron pointed with ſteel, having a male ſcrew which goes into the female one in the head about four inches. Through the eye *g* of this ſpindle is faſtened the bar *k*, by which the preſſman makes the impreſſion. The ſpindle paſſes through a hole in the middle of the till; and its point works into a braſs pan or nut, ſupplied with oil, which is fixed to an iron plate let into the top of the platten. The body of the ſpindle is ſuſtained in the centre of an open frame of poliſhed iron, 1, 1, 2, 2, 3, 3, fixed to it in ſuch a manner as, without obſtructing its free play, to keep it in a ſteady direction; and at the ſame time to ſerve for ſuſpending the platten. This frame conſiſts of two parts; the upper called the *garter*, 1, 1; the under, called the *crane*, 2, 2. Theſe are connected together by two ſhort legs or bolts, 3, 3; which being fixed below in the two ends of the crane, paſs upward, through two holes in the till, and are received at top into two eyes at the ends of the garter, where they are ſecured by ſcrews. The carriage *l l* is placed a foot below the platten, having its fore-part ſupported by a prop called the *fore-ſtay*, while the other reſts on the winter. On this carriage, which ſuſtains the plank, are nailed two long iron bars or ribs; and on the plank are nailed ſhort pieces of iron or ſteel called *cramp irons*, equally tempered with the ribs, and which ſlide upon them when the plank is turned in or out. Under the carriage is fixed a long piece of iron called the *ſpit*, with a double wheel in the middle, round which leather-girts are faſtened, nailed to each end of the plank: and to the outſide of the ſpit is fixed a rounce *m*, or handle to turn round the wheel. Upon the plank is a ſquare frame or coffin, in which is incloſed a poliſhed ſtone on which the form *n* is laid; at the end of the coffin are three frames, *viz*. the two tympans and friſket: the tympans *o* are ſquare, and made of three ſlips of very thin wood, and at the top a piece of iron ſtill thinner; that called the *outer tympan* is faſtened with hinges to the coffin: they are both covered with parchment; and between the two are placed blankets, which are neceſſary to take off the impreſſion of the letters upon the paper. The friſket *p* is a ſquare frame of thin iron, faſtened with hinges to the tympan: it is covered with paper cut in the neceſſary places, that the ſheet, which is put between the friſket and the great or outward tympan, may receive the ink, and that nothing may hurt the margins. To regulate the margins, a ſheet of paper is faſtened upon this tympan, which is called the *tympan ſheet*; and on each ſide is fixed an iron point, which makes two holes in the ſheet, which is to be placed on the ſame points when the impreſſion is to be made on the other ſide. In preparing the preſs for working, the parchment which covers the outer tympan is wetted till it is very ſoft, in order to render the impreſſion more equable; the blankets are then put in, and ſecured from ſlipping by the inner tympan: then while one preſsman is beating the letter with the balls *q*, covered with ink taken from the ink-block, the other perſon places a ſheet of white paper on the tympan-ſheet; turns down the friſket upon it, to keep the paper clean and prevent its ſlipping; then bringing the tympans upon the form, and turning the rounce, he brings the form with the ſtone, &c. weighing about 300 lbs. weight, under the platten; pulls with the bar, by which means the platten preſſes the blankets and paper cloſe upon the letter, whereby half the form is printed; then eaſing the bar, he draws the form ſtill forward; gives a ſecond pull; and letting go the bar, turns back the form, takes up the tympans and friſket, takes out the printed ſheet, and lays on a freſh one; and this is repeated till he has taken off the impreſſion upon the full number of ſheets the edition is to conſiſt of. One ſide of the ſheet being thus printed, the form for the other is laid upon the preſs, and worked off in the ſame manner.

Chineſe PRINTING, is performed from wooden planks or blocks, cut like thoſe uſed in printing of callico, paper, cards, &c.

Rolling-preſs PRINTING, is employed in taking off prints or impreſſions from copperplates engraven, etched, or ſcraped, as in mezzotintos. See ENGRAVING.

This art is ſaid to have been as ancient as the year 1540, and to owe its origin to Finiguerra, a Florentine goldſmith, who pouring ſome melted brimſtone on an engraven plate, found the exact impreſſion of the engraving left in the cold brimſtone, marked with black taken out of the ſtrokes by the liquid ſulphur: upon this he attempted to do the ſame on ſilver plates with wet paper, by rolling it ſmoothly with a roller; and this ſucceeded: but this art was not uſed in England till the reign of king James I. when it was brought from Antwerp by Speed. The form of the rolling-

presſ, the compoſition of the ink uſed therein, and the manner of applying both in taking off prints, are as follow:

Plate CCCCXV.

The rolling-preſs AL, nº 3. may be divided into two parts, the body and carriage: the body conſiſts of two wooden cheeks PP, placed perpendicularly on a ſtand or foot LM, which ſuſtains the whole preſs. From the foot likewiſe are four other perpendicular pieces *c*, *c*, *c*, *c*, joined by other croſs or horizontal ones *d*, *d*, *d*, which ſerve to ſuſtain a ſmooth even plank or table HIK, about four feet and a half long, two feet and a half broad, and an inch and a half thick. Into the cheeks go two wooden cylinders or rollers, DE, FG, about ſix inches in diameter, borne up at each end by the cheeks, whoſe ends, which are leſſened to about two inches diameter, and called *trunnions*, turn in the cheeks about two pieces of wood in form of half-moons, lined with poliſhed iron to facilitate the motion. Laſtly, to one of the trunnions of the upper roller is faſtened a croſs, conſiſting of two levers AB, or pieces of wood, traverſing each other, the arms of which croſs ſerve inſtead of the bar or handle of the letter-preſs, by turning the upper roller, and when the plank is between the two rollers, giving the ſame motion to the under one, by drawing the plank forward and backward.

The ink uſed for copperplates, is a compoſition made of the ſtones of peaches and apricots, the bones of ſheep and ivory, all well burnt, and called *Frankfort black*, mixed with nut-oil that has been well boiled, and ground together on a marble, after the ſame manner as painters do their colours.

The method of printing from copperplates is as follows: They take a ſmall quantity of this ink on a rubber made of linen-rags, ſtrongly bound about each other, and therewith ſmear the whole face of the plate as it lies on a grate over a charcoal fire. The plate being ſufficiently inked, they firſt wipe it over with a foul rag, then with the palm of their left hand, and then with that of the right; and to dry the hand and forward the wiping, they rub it from time to time in whiting. In wiping the plate perfectly clean, yet without taking the ink out of the engraving, the addreſs of the workman conſiſts. The plate thus prepared, is laid on the plank of the preſs; over the plate is laid the paper, firſt well moiſtened, to receive the impreſſion; and over the paper two or three folds of flannel. Things thus diſpoſed, the arms of the croſs are pulled, and by that means the plate with its furniture paſſed through between the rollers, which pinching very ſtrongly, yet equally, preſſes the moiſtened paper into the ſtrokes of the engraving, whence it licks out the ink.

PRINTS, the impreſſions taken from a copperplate. See the laſt article, and ENGRAVING.

Strutt's Dict. of Engravers.

From the facility of being multiplied, prints have derived an advantage over paintings by no means inconſiderable. They are found to be more durable; which may, however, in ſome degree be attributed to the different methods in which they are preſerved. Many of the beſt paintings of the early maſters have generally had the misfortune to be either painted on walls, or depoſited in large and unfrequented, and conſequently damp and deſtructive, buildings; whilſt a print, paſſing, at diſtant intervals, from the *porte feuille* of one collector to that of another, is preſerved without any great exertion of its owner: And hence it happens, that whilſt the pictures of Raphael have mouldered from their walls, or deſerted their canvas, the prints of his friend and cotemporary Mark Antonio Raimondi continue in full perfection to this day, and give us a lively idea of the beauties of thoſe paintings, which, without their aſſiſtance, had been loſt to us for ever; or at leaſt, could have been only known to us, like thoſe of Zeuxis and Apelles, by the deſcriptions which former writers on theſe ſubjects have left us.

Independent of the advantages which prints afford us, when conſidered as accurate repreſentations of paintings, and imitations of ſuperior productions, they are no leſs valuable for their poſitive merit, as immediate repreſentations of nature. For it muſt be recollected, that the art of engraving has not always been confined to the copying other productions, but has frequently itſelf aſpired to originality, and has, in this light, produced more inſtances of its excellence than in the other. Albert Durer, Goltzius, and Rembrandt, amongſt the Dutch and Germans; Parmigiano and Della Bella amongſt the Italians, and Callot amongſt the French, have publiſhed many prints, the ſubjects of which, there is great reaſon to ſuppoſe, were never painted. Theſe prints may therefore be conſidered as original pictures of thoſe maſters, deficient only in thoſe particulars in which a print muſt neceſſarily be inferior to a painting.

The preceding diſtinction may perhaps throw ſome light on the proper method of arranging and claſſing a collection of prints, which has been a matter of no ſmall difficulty. As an art imitating another, the principal ſhould take the lead, and the deſign, compoſition, and drawing, in a print, being previous requiſites to the manner of execution and finiſhing; prints engraved after paintings ſhould be arranged under the name of the painter; and every perſon who looks upon engraving only as auxiliary to painting, will conſequently adopt this mode of arrangement. But when engraving is conſidered as an original art, as imitating nature without the intervention of other methods, then it will certainly be proper to regulate the arrangement according to the names of the engravers.

PRIOR, in general, ſomething before or nearer the beginning than another, to which it is compared.

PRIOR, more particularly denotes the ſuperior of a convent of monks, or the next under the abbot. See ABBOT.

Priors are either *clauſtral* or *conventual*. *Conventual* are the ſame as abbots. *Clauſtral* prior, is he who governs the religious of an abbey or priory *in commendam*, having his juriſdiction wholly from the abbot.

Grand PRIOR, is the ſuperior of a large abbey, where ſeveral ſuperiors are required.

PRIOR (Matthew), an eminent Engliſh poet, was born at London in 1664. His father dying while he was very young, an uncle a vintner, having given him ſome education at Weſtminſter ſchool, took him home in order to breed him up to his trade. However, at his leiſure hours he proſecuted his ſtudy of the claſſics, and eſpecially of his favourite Horace. This introduced

troduced him to fome polite company, who frequented his uncle's houfe; among whom the earl of Dorfet took particular notice of him, and procured him to be fent to St John's college in Cambridge, where, in 1686, he took the degree of A. B. and afterwards became fellow of that college. Upon the revolution, Mr Prior was brought to court by the earl of Dorfet; and in 1690 he was made fecretary to the earl of Berkeley, plenipotentiary at the Hague; as he was afterward to the ambaffador and plenipotentiaries at the treaty of Ryfwick in 1697; and the year following to the earl of Portland, ambaffador to the court of France. He was in 1697 made fecretary of ftate for Ireland; and in 1700 was appointed one of the lords commiffioners of trade and plantations. In 1710, he was fuppofed to have had a fhare in writing *The Examiner*. In 1711, he was made one of the commiffioners of the cuftoms; and was fent minifter plenipotentiary to France, for the negotiating a peace with that kingdom. Soon after the acceffion of George I. to the throne in 1714, he prefented a memorial to the court of France, requiring the demolifhing of the canal and new works at Mardyke. The year following he was recalled; and upon his arrival was taken up by a warrant from the houfe of commons, and ftrictly examined by a committee of the privy-council. Robert Walpole, Efq; moved the houfe of commons for an impeachment againft him; and Mr Prior was ordered into clofe cuftody. In 1717, he was excepted out of the act of grace; however, at the clofe of that year, he was fet at liberty. The remainder of his days he fpent in tranquillity and retirement; and died in 1721. His poems are well known, and juftly admired. He is faid to have written the following epitaph for himfelf:

> "Nobles and heralds, by your leave,
> Here lie the bones of Matthew Prior,
> The fon of Adam and of Eve:
> Let Bourbon or Naffau go higher."

Alien Priories, were cells of the religious houfes in England which belonged to foreign monafteries: for when manors or tithes were given to foreign convents, the monks, either to increafe their own rule, or rather to have faithful ftewards of their revenues, built a fmall convent here for the reception of fuch a number as they thought proper, and conftituted priors over them.—Within thefe cells there was the fame diftinction as in thofe priories which were cells fubordinate to fome great abbey; fome of thefe were conventual, and, having priors of their own choofing, thereby became entire focieties within themfelves, and received the revenues belonging to their feveral houfes for their own ufe and benefit, paying only the ancient apport (A), acknowledgment, or obvention, at firft the furplufage, to the foreign houfe; but others depended entirely on the foreign houfes, who appointed and removed their priors at pleafure. Thefe tranfmitted all their revenues to the foreign head houfes; for which reafon their eftates were generally feized to carry on the wars between England and France, and reftored to them again on return of peace. Thefe alien priories were moft of them founded by fuch as had foreign abbeys founded by themfelves or by fome of their family.

The whole number is not exactly afcertained; the Monafticon hath given a lift of 100: Weever, p. 338. fays 110.

Some of thefe cells were made indigenous or denizon, or endenized. The alien priories were firft feized by Edward I. 1285, on the breaking out of the war between France and England; and it appears from a roll, that Edward II. alfo feized them, though this is not mentioned by our hiftorians; and to thefe the act of reftitution 1 Ed. III. feems to refer.

In 1337, Edward III. confifcated their eftates, and let out the priories themfelves with all their lands and tenements, at his pleafure, for 23 years; at the end of which term, peace being concluded between the two nations, he reftored their eftates 1361, as appears by his letters patent to that of Montacute, county of Somerfet, printed at large in Rymer, vol. vi. p. 311. and tranflated in Weever's *Funeral Monuments*, p. 339. At other times he granted their lands, or lay penfions out of them, to divers noblemen. They were alfo fequeftered during Richard II.'s reign, and the head monafteries abroad had the king's licence to fell their lands to other religious houfes here, or to any particular perfons who wanted to endow others.

Henry IV. began his reign with fhowing fome favour to the alien priories, reftoring all the conventual ones, only referving to himfelf in time of war what they paid in time of peace to the foreign abbeys.

They were all diffolved by act of parliament 2 Henry V. and all their eftates vefted in the crown, except fome lands granted to the college of Fotheringhay. The act of diffolution is not printed in the ftatute books, but it is to be found entire in Rymer's *Fœdera*, IX. 283. and in the Parliament Rolls, vol. iv. p. 22. In general, thefe lands were appropriated to religious ufes. Henry VI. endowed his foundations at Eton and Cambridge with the lands of the alien priories, in purfuance of his father's defign to appropriate them all to a noble college at Oxford. Others were granted in fee to the prelates, nobility, or private perfons. Such as remained in the crown were granted by Henry VI. 1440, to archbifhop Chichley, &c. and they became part of his and the royal foundations. See *Some Account of Alien-Priories*, &c. in two volumes octavo.

PRIORITY, the relation of fomething confidered as prior to another.

Priority, in law, denotes an antiquity of tenure, in comparifon of another lefs ancient.

PRISCIANUS, an eminent grammarian, born at Cæfarea, taught at Conftantinople with great reputation about the year 525. Laurentius Valla calls Prifcian, Donatus, and Servius, *triumviri in re grammatica*; and thinks none of the ancients who wrote after them fit to be mentioned with them. He compofed a work *De arte grammatica*, which was firft printed by Aldus at

(A) *Apportus* or *apportagium* (from *portare*), an acknowledgment, oblation, or obvention, to the mother houfe or church. *Du Cange*.

at Venice in 1476; and another *De naturalibus quæstionibus*, which he dedicated to Chosroes king of Persia: beside which, he translated Dionysius's description of the world into Latin verse. A person who writes false Latin, is proverbially said to "break Priscian's head."

PRISCILLIANISTS, in church-history, Christian heretics, so called from their leader Priscillian, a Spaniard by birth, and bishop of Avila. He is said to have practised magic, and to have maintained the principal errors of the Manichees; but his peculiar tenet was, That it is lawful to make false oaths in order to support one's cause and interests.

PRISM, an oblong solid, contained under more than four planes, whose bases are equal, parallel, and alike situated. See OPTICS, n° 142.

PRISON, a gaol, or place of confinement.

Lord Coke observes, that a prison is only a place of safe custody, *salva custodia*, not a place of punishment. If this be so, and it cannot be questioned, prisons ought not to be, what they are in most parts of of Europe, loathsome dungeons. Any place where a person is confined may be said to be a prison; and when a process is issued against one, he must, when arrested thereon, either be committed to prison, or be bound in a recognizance with sureties, or else give bail, according to the nature of the case, to appear at a certain day in court, there to make answer to what is alleged against him. Where a person is taken and sent to prison, in a civil case, he may be released by the plaintiff in the suit; but if it be for treason or felony, he may not regularly be discharged, until he is indicted of the fact and acquitted. See INDICTMENT, and the next article.

PRISONER, a person restrained or kept in prison upon an action civil or criminal, or upon commendment: and one may be a prisoner on matter of record or matter of fact. A prisoner upon matter of record, is he who, being present in court, is by the court committed to prison; and the other is one carried to prison upon an arrest, whether it be by the sheriff, constable, or other officer.

PRISTIS, the SAWFISH, is generally considered as a species of the *squalus* or *shark* genus, comprehending under it several varieties. Mr Latham, however, is of opinion that it ought to be considered as a distinct genus itself, and that the characteristics of the several varieties are sufficient to constitute them distinct species. According to him therefore the *pristis* is a genus belonging to the order of *amphibia nantes;* and its characters are as follow: A long plane beak or snout, with spines growing like teeth out of both edges; four or five *spiracula*, or breathing apertures, in the sides of the neck: the body is oblong and almost round, with a rough coriaceous skin; the mouth is situated in the lower part of the head; and the nostrils, before the mouth, are half covered with a membranaceous lobe; behind the eyes are two oval holes; the ventral fins approach one another, and in the male are placed about the organs of generation; there are no fins at the anus. Of this genus our author enumerates five species.

1. *Pristis antiquorum.* The head is rather flat at top; the eyes large, with yellow irides; behind each is a hole, which some have supposed may lead to an organ of hearing. The mouth is well furnished with teeth, but they are blunt, serving rather to bruise its prey than to divide it by cutting. Before the mouth are two foramina, supposed to be the nostrils. The *rostrum*, beak, or snout, is in general about one-third of the total length of the fish, and contains in some 18, in others as far as 23 or 24 spines on each side; these are very stout, much thicker at the back-part, and channelled, inclining to an edge forwards. The fins are seven in number—viz. two dorsal, placed at some distance from each other—two pectoral, taking rise just behind the breathing-holes, which are five in number—two ventral, situated almost underneath the first dorsal—and lastly the caudal, occupying the tail both above and beneath, but longest on the upper part. The general colour of the body is a dull grey, or brownish, growing paler as it approaches the belly, where it is nearly white. 2. *Pectinatus*, which, with the former species, grows to the largest size of any that have yet come under the inspection of the naturalist, some specimens measuring 15 feet in length. The pectinatus differs from the pristis antiquorum, in having the snout more narrow in proportion at the base, and the whole of it more slender in all its parts; whereas the first is very broad at the base, and tapers considerably from thence to the point. The spines on each side also are longer and more slender, and vary from 25 to 34 in the different specimens: we have indeed been informed of one which contained no less than 36 spines on each side of the snout; but we must confess that we have never been fortunate enough to have seen such a specimen. 3. *Cuspidatus*, of which our author has seen only two specimens, the one about a foot and a half in length, and the other more than two feet and a half. In both of these were 28 spines on each side; but the distinguishing feature is in the spines themselves, being particularly flat and broad, and shaped at the point more like the lancet used by surgeons in bleeding, than any other figure. We believe that no other author has hitherto taken notice of this species. 4. *Microdon*, of which the total length is 28 inches, the snout occupying 10; from the base of this to that of the pectoral fins four inches; between the pectoral and ventral fins six. The two dorsal fins occupy nearly the same proportions in respect to each other; but the hinder one is the smallest, and all of them are greatly hollowed out at the back-part, much more so than in the two first species. The snout differs from that of every other, in several particulars: it is longer in proportion, being more than one-third of the whole fish. The spines do not stand out from the sides more than a quarter of an inch, and from this circumstance seem far less capable of doing injury than any other species yet known. 5. *Cirratus*, of which, continues our author, we have only met with one specimen, which was brought from Port Jackson in New Holland. It is a male, and the total length about 40 inches: the snout, from the tip of it to the eye, 11: the spines widely different from any of the others; they are indeed placed, as usual, on the edge, but are continued on each side even beyond the eyes. The longer ones are slender, sharp, somewhat bent, and about 20 in number; and between these are others not half the length of the primal ones, between some three or four, between others as far as six; and in general the middle one of these smaller series is the longest: beside these a series

series of minute ones may be perceived beneath, at the very edge. In the snout likewise another singularity occurs:—about the middle of it, on each side, near the edge, arises a flexible, ligamentous cord, about three inches and a half in length, appearing not unlike the beards at the mouth of some of the gadus or cod genus, and no doubt as pliant in the recent state. The colour of the fish is a pale brown: the breathing apertures four in number: the mouth furnished with five rows of minute, but very sharp teeth. See Plate CCCCXVI. where the snout marked 1 is that of the pristis antiquorum; that marked 2, of pectinatus; and that marked 4, of microdon: the entire fish is the cirratus.

PRIVATEERS, are a kind of private men of war, the persons concerned wherein administer at their own costs a part of a war, by fitting out these ships of force, and providing them with all military stores; and they have, instead of pay, leave to keep what they take from the enemy, allowing the admiral his share, &c.

Privateers may not attempt any thing against the laws of nations; as to assault an enemy in a port or haven, under the protection of any prince or republic, whether he be friend, ally, or neuter; for the peace of such places must be inviolably kept: therefore, by a treaty made by King William and the States of Holland, before a commission shall be granted to any privateer, the commander is to give security, if the ship be not above 150 tons, in L. 1500, and if the ship exceeds that burden, in L. 3000, that they will make satisfaction for all damages which they shall commit in their courses at sea, contrary to the treaties with that state, on pain of forfeiting their commissions; and the ship is made liable.

Jacob's Law Dict. Besides these private commissions, there are special commissions for privateers, granted to commanders of ships, &c. who take pay; who are under a marine discipline; and if they do not obey their orders, may be punished with death: and the wars in later ages have given occasion to princes to issue these commissions, to annoy the enemies in their commerce, and hinder such supplies as might strengthen them or lengthen out the war; and likewise to prevent the separation of ships of greater force from their fleets or squadrons.

Ships taken by privateers were to be divided into five parts; four parts whereof to go to the persons interested in the privateer, and the fifth to his Majesty: and as a farther encouragement, privateers, &c. destroying any French man of war or privateer, shall receive, for every piece of ordnance in the ship so taken, L. 10 reward, &c.

By a particular statute lately made, the lord admiral, or commissioners of the admiralty, may grant commissions to commanders of privateers, for taking ships, &c. which being adjudged prize, and the tenth part paid to the admiral, &c. wholly belong to the owners of the privateers and the captors, in proportions agreed on between themselves.

PRIVATION, in a general sense, denotes the absence or want of something; in which sense darkness is only the privation of light.

PRIVATIVE, in grammar, a particle, which, prefixed to a word, changes it into a contrary sense. Thus, among the Greeks, the α is used as a privative; as in α-θεος, *atheist*, *acephalus*, &c.—The Latins have their privative *in*; as, *incorrigibilis*, *indeclinabilis*, &c.—The English, French, &c. on occasion borrow both the Latin and Greek privatives.

PRIVERNUM, (Livy, Virgil); a town of the Volsci, in Latium, to the east of Setia. *Privernates*, the people. Whose ambassadors being asked, What punishment they deserved for their revolt? answered, What those deserve who deem themselves worthy of liberty. And again, being asked by the Roman consul, should the punishment be remitted, What peace was to be expected with them? If you grant a good peace, you may hope to have it sincere and lasting; but if a bad one, you may well expect it of short continuance. At which answer, the Romans were so far from being displeased, that by a vote of the people they had the freedom of the city granted them. *Privernas, atis*, the epithet. The town is now called *Piperno Vecchio*, situated in the Campania of Rome. E. Long. 10. 0. N. Lat. 41. 30.

PRIVET, in botany. See LIGUSTRUM.

PRIVILEGE, in law, some peculiar benefit granted to certain persons or places, contrary to the usual course of the law.

Privileges are said to be *personal* or *real*.

Personal privileges are such as are extended to peers, ambassadors, members of parliament, and of the convocation, &c. See LORDS, AMBASSADOR, PARLIAMENT, ARREST, &c.

A *real* privilege is that granted to some particular place; as the king's palace, the courts at Westminster, the universities, &c.

PRIVILEGES of the Clergy. See CLERGY.

PRIVY, in law, is a partaker, or person having an interest, in any action or thing. In this sense they say, privies in blood: every heir in tail is privy to recover the land intailed. In old law-books, merchants privy are opposed to merchants strangers. Coke mentions four kinds of privies. Privies in blood, as the heir to his father; privies in representation, as executors and administrators to the deceased; privies in estate, as he in reversion, and he in remainder donor and donee; lessor and lessee: lastly, privy in tenure, as the lord by escheat; *i.e.* when land escheats to the lord for want of heirs.

PRIVY-Council. See COUNCIL. The king's will is the sole constituent of a privy-counsellor; and it also regulates their number, which in ancient times was about twelve. Afterwards it increased to so large a number, that it was found inconvenient for secrecy and dispatch; and therefore Charles II. in 1679, limited it to 30; whereof 15 were principal officers of state, and to be counsellors *ex officio*; and the other 15 were composed of 10 lords and five commoners of the king's choosing. Since that time however the number has been much augmented, and now continues indefinite. At the same time also, the ancient office of lord president of the council was revived, in the person of Anthony earl of Shaftesbury. Privy-counsellors are made by the king's nomination, without either patent or grant; and, on taking the necessary oaths, they become immediately privy-counsellors during the life of the king that chooses them, but subject to removal at his discretion.

Any natural born subject of England is capable of being a member of the privy-council; taking the proper oaths for security of the government, and the test for security of the church. By the act of settlement, 12 and 13 W. III. cap. 2. it is enacted, that no person born out of the dominions of the crown of England, unless born of English parents, even though naturalized by parliament, shall be capable of being of the privy-council. The duty of a privy-counsellor appears from the oath of office, which consists of seven articles. 1. To advise the king according to the best of his cunning and discretion. 2. To advise for the king's honour and good of the public, without partiality, through affection, love, meed, doubt, or dread. 3. To keep the king's counsel secret. 4. To avoid corruption. 5. To help and strengthen the execution of what shall be there resolved. 6. To withstand all persons who would attempt the contrary. And, lastly, in general, 7. To observe, keep, and do all that a good and true counsellor ought to do to his sovereign lord.

The privy-council is the *primum mobile* of the state, and that which gives the motion and direction to all the inferior parts. It is likewise a court of justice of great antiquity; the primitive and ordinary way of government in England being by the king and privy-council. It has been frequently used by all our kings for determining controversies of great importance: the ordinary judges have sometimes declined giving judgment till they had consulted the king and privy-council; and the parliament have frequently referred matters of high moment to the same, as being by long experience better able to judge of, and, by their secrecy and expedition, to transact some state affairs, than the lords and commons. At present, the privy-council takes cognizance of few or no matters except such as cannot well be determined by the known laws and ordinary courts; such as matters of complaint and sudden emergencies: their constant business being to consult for the public good in affairs of state. This power of the privy-council is to inquire into all offences against the government, and to commit the offenders to safe custody, in order to take their trial in some of the courts of law. But their jurisdiction herein is only to inquire, and not to punish; and the persons committed by them are intitled to their *habeas corpus* by statute 16 Car. I. cap. 10. as much as if committed by an ordinary justice of the peace.

In plantation or admiralty causes, which arise out of the jurisdiction of this kingdom, and in matters of lunacy and idiocy, the privy-council has cognizance, even in questions of extensive property, being the court of appeal in such causes; or, rather, the appeal lies to the king's majesty himself in council. From all the dominions of the crown, excepting Great Britain and Ireland, an appellate jurisdiction (in the last resort) is vested in this tribunal; which usually exercises its judicial authority in a committee of the whole privy-council, who hear the allegations and proofs, and make their report to his majesty in council, by whom the judgment is finally given.

Anciently, to strike in the house of a privy-counsellor, or elsewhere in his presence, was grievously punished: by 3 Hen. VII. cap. 14. if any of the king's servants of his household conspire or imagine to take away the life of a privy-counsellor, it is felony, though nothing shall be done upon it; and by 9 Ann, cap. 16. it is enacted, that any persons who shall unlawfully attempt to kill, or shall unlawfully assault, and strike, or wound, any privy-counsellor in the execution of his office, shall be felons, and suffer death as such. With advice of this council, the king issues proclamations that bind the subject, provided they be not contrary to law. In debates, the lowest delivers his opinion first, the king last; and thereby determines the matter. A council is never held without the presence of a secretary of state.

The dissolution of the privy-council depends upon the king's pleasure; and he may, whenever he thinks proper, discharge any particular member, or the whole of it, and appoint another. By the common law also it was dissolved *ipso facto* by the king's demise, as deriving all its authority from him. But now, to prevent the inconveniences of having no council in being at the accession of a new prince, it is enacted, by 6 Ann, cap. 7. that the privy-council shall continue for six months after the demise of the crown, unless sooner determined by the successor. *Blackst. Com.* book i. p. 229, &c.

The officers of the privy-council are four clerks of the council in ordinary, three clerks extraordinary, a keeper of the records, and two keepers of the council-chamber. See PRESIDENT,

PRIVY Seal, a seal which the king uses previously to such grants, &c. as are afterwards to pass the great seal.

The privy seal is also sometimes used in matters of less consequence, which do not require the great seal.

Lord PRIVY Seal. See *KEEPER of the Privy Seal*.

Clerks of the PRIVY Seal. See CLERK.

PRIVY Chamber. See CHAMBER.

PRIZE, or PRISE, in maritime affairs, a vessel taken at sea from the enemies of a state, or from pirates; and that either by a man of war, a privateer, &c. having a commission for that purpose.

Vessels are looked on as prize, if they fight under any other standard than that of the state from which they have their commission; if they have no charter-party, invoice, or bill of lading aboard; if loaded with effects belonging to the king's enemies, or with contraband goods.

In ships of war, the prizes are to be divided among the officers, seamen, &c. as his Majesty shall appoint by proclamation; but among privateers, the division is according to the agreement between the owners.

By stat. 13 Geo. II. c. 4. judges and officers, failing of their duty in respect to the condemnation of prizes, forfeit L. 500, with full costs of suit; one moiety to the king, and the other to the informer.

PROA, FLYING, in navigation, is a name given to a vessel used in the south seas, because with a brisk trade-wind it sails near 20 miles an hour. In the construction of the proa, the head and stern are exactly alike, but the sides are very different; the side intended to be always the lee-side being flat; and the windward side made rounding, in the manner of other vessels; and, to prevent her over-setting, which from her small breadth, and the straight run of her leeward side, would, without this precaution, infallibly happen, there is a frame laid out to her from windward, to the end of which is fastened a log, fashioned into the shape of a small boat, and made hollow. The weight of the

frame is intended to balance the proa, and the small boat is by its buoyancy (as it is always in the water) to prevent her oversetting to windward; and this frame is usually called an outrigger. The body of the vessel is made of two pieces joined endwise, and sewed together with bark, for there is no iron used about her; she is about two inches thick at the bottom, which, at the gunwale, is reduced to less than one. The sail is made of matting, and the mast, yard, boom, and outriggers, are all made of bamboo. See *Anson's Voyage*, quarto, p. 341.

PROBABILITY is a word of nearly the same import with likelihood. It denotes the appearance of truth, or that evidence arising from the preponderation of argument which produces opinion. (See OPINION.) Locke classes all arguments under the heads of *demonstrative* and *probable*: Hume with greater accuracy divides them into *demonstrations*, *proofs*, and *probabilities*. Demonstration produces *science*; proof, *belief*; and probability, *opinion*.

Hardly any thing is susceptible of strict demonstration besides the mathematical sciences, and a few propositions in metaphysical theology. Physics rest upon principles capable, some of them, of complete proof by experience, and others of nothing more than probability by analogical reasoning. What has *uniformly* happened, we expect with the fullest confidence to happen again in similar circumstances; what has *frequently* happened, we likewise expect to happen again; but our expectation is not confident. Uniform experience is proof; frequent experience is probability. The strongest man has *always* been able to lift the greatest weight; and, therefore, knowing that one man is stronger than another, we expect, with confidence, that the former will lift more than the latter. The best disciplined army has *generally* proved victorious, when all other circumstances were equal. We therefore expect that an army of veterans will, upon fair ground, defeat an equal number of new levied troops: but as sudden panics have sometimes seized the oldest soldiers, this expectation is accompanied with doubt, and the utmost that we can say of the expected event is, that it is *probable*; whereas in the competition between the two men, we look upon it as *morally certain*. (See METAPHYSICS, part 1. chap. vii. sec. 3.) When two or three persons of known veracity attest the same thing as consistent with their knowledge, their testimony amounts to *proof*, if not contradicted by the testimony of others; if contradicted, it can, at the utmost, amount only to probability. In common language we talk of *circumstantial* proofs and *presumptive* proofs; but the expressions are improper, for such evidence amounts to nothing more than probability. Of probability there are indeed various degrees from the confines of certainty down to the confines of impossibility; and a variety of circumstances tending to the same point, though they amount not to what, in strictness of language, should be called *proof*, afford to the mind a very high degree of evidence, upon which, with the addition of one direct testimony, the laws of many countries take away the life of a man.

PROBABILITY *of an Event*, in the *Doctrine of Chances*, is greater or less according to the number of chances by which it may happen or fail. (See EXPECTATION). The *probability of life* is liable to rules of computation. In the *Encyclopedie Methodique*, we find a table of the probabilities of the duration of life, constructed from that which is to be found in the seventh volume of the *Supplemens à l'Histoire de M. de Buffon*; of which the following is an abridgement.

Of 23,994 children born at the same time, there will probably die

$\frac{1}{3}$	In one year - -	7998
$\frac{2}{3}$	Remaining $\frac{2}{3}$ or 15996	
$\frac{1}{2}$	In eight years - -	11997
$\frac{1}{2}$	Remaining $\frac{1}{2}$ or 11997	
$\frac{2}{3}$	In thirty eight years -	15996
$\frac{1}{3}$	Remaining $\frac{1}{3}$ or 7998	
$\frac{3}{4}$	In fifty years - -	17994
$\frac{1}{4}$	Remaining $\frac{1}{4}$ or 5998	
$\frac{5}{6}$	In sixty one years - -	19995
$\frac{1}{6}$	Remaining $\frac{1}{6}$ or 3999	
$\frac{9}{10}$	In seventy years - -	21595
$\frac{1}{10}$	Remaining $\frac{1}{10}$ or 2399	
$\frac{39}{40}$	In eighty years -	22395
$\frac{1}{40}$	Remaining $\frac{1}{40}$ or 599	
$\frac{299}{300}$	In ninety years - -	23914
$\frac{1}{300}$	Remaining $\frac{1}{300}$ or 80	
	In an hundred years -	23992

Remaining $\frac{1}{10000}$ or 2. See *Bills of* MORTALITY.

PROBATE of a will or testament, in law, is the exhibiting and proving of last wills and testaments before the ecclesiastical judge delegated by the bishop, who is ordinary of the place where the party died.

PROBATION, in the universities, is the examination and trial of a student who is about to take his degrees.

PROBATION, in a monastic sense, signifies the year of a novitiate, which a religious must pass in a convent, to prove his virtue and vocation, and whether he can bear the severities of the rule.

PROBATION, in Scots law. See LAW, p. 714.

PROBATIONER, in the church of Scotland, a student in divinity, who bringing a certificate from a professor in an university of his good morals, and his having performed his exercises to approbation, is admitted to undergo several trials; and, upon his acquitting himself properly in these, receives a licence to preach.

PROBATUM EST (*It is proved*), a term frequently subjoined to a receipt for the cure of some disease.

PROBE, a surgeon's instrument for examining the circumstances of wounds, ulcers, and other cavities, searching for stones in the bladder, &c.

PROBITY means honesty, sincerity, or veracity; and consists in the habit of actions useful to society, and in the constant observance of the laws which justice and conscience impose on us. The man who obeys all the laws of society with an exact punctuality is not therefore a man of probity; laws can only respect the external and definite parts of human conduct, but probity respects our more private actions, and such as it is impossible in all cases to define; and it appears to be in morals what charity is in religion. Probity teaches us to perform in society those actions which no external power can oblige us to perform, and is that quality in the human mind from which we claim the performance of the *rights* commonly called *imperfect*. See MORAL PHILOSOPHY.

PROBLEM, in logic, is a propofition that neither appears abfolutely true nor falfe; and, confequently, may be afferted either in the affirmative or negative.

Problem, in geometry, is a propofition, wherein fome operation or conftruction is required; as to divide a line or angle, erect or let fall perpendiculars, &c. See Geometry.

PROBOSCIS, in natural hiftory, is the trunk or fnout of an elephant, and fome other animals and infects.

Flies, gnats, &c. are furnifhed with a probofcis or trunk; by means of which they fuck the blood of animals, the juice of vegetables, &c. for their food.

PROBUS (Marcus Aurelius), from the fon of a gardener, became, by his great valour as a foldier, and his eminent virtues, emperor of Rome, to which dignity he was raifed by the army. After having fubdued the barbarous nations that had made incurfions into different parts of the empire, where they committed horrid cruelties, and governed with great wifdom and clemency, he was maffacred in the 7th year of his reign, by fome foldiers who were weary of the public works at which he made them labour, in 282.

PROCATARCTIC cause, in medicine, the preexifting, or predifpofing caufe or occafion of a difeafe.

PROCELEUSMATICUS, in the ancient poetry, a foot confifting of four fhort fyllables, or two pyrrhychiufes; as *hominibus*.

PROCELLARIA, in ornithology; a genus of birds, belonging to the order of anferes. The beak is fomewhat compreffed, and without teeth; the mandibles are equal, the fuperior one being crooked at the point; the feet are palmated, the hind claw being feffile, without any toe. Mr Latham (See his *Index Ornithologicus*, p. 820.) enumerates 24 fpecies, which are principally diftinguifhed by their colour. The moft remarkable are,

1. The cinerea, or petrel. The fize of this bird is rather fuperior to that of the common gull: the bill very ftrong, much hooked at the end, and of a yellow colour. The noftrils are compofed of two large tubes, lodged in one fheath: the head, neck, whole under fide of the body, and tail, are white: the back and coverts of the wings afh-coloured: the quill-feathers dufky: and the legs yellowifh. In lieu of a back toe, it has only a fort of fpur, or fharp ftraight nail. Thefe birds feed on the blubber or fat of whales, &c. which being foon convertible into oil, fupplies them conftantly with means of defence, as well as provifion for their young, which they caft up into their mouths. They are likewife faid to feed on forrel, which they ufe to qualify the unctuous diet they live on. This fpecies inhabits the ifle of St Kilda; makes its appearance there in November, and continues the whole year, except September and October; it lays a large, white, and very brittle egg; and the young are hatched the middle of June. No bird is of fuch ufe to the iflanders as this: the fulmar fupplies them with oil for their lamps, down for their beds, a delicacy for their tables, a balm for their wounds, and a medicine for their diftempers. The fulmar is alfo a certain prognofticator of the change of the wind: if it comes to land, no weft wind is expected for fome time; and the contrary when it returns and keeps the fea. The whole genus of petrels have a peculiar faculty of fpouting from their bills, to a confiderable diftance, a large quantity of pure oil; which they do, by way of defence, into the face of any one that attempts to take them: fo that they are, for the fake of this panacæa, feized by furprife; as this oil is fubfervient to the abovementioned medical purpofes. Martin tells us, it has been ufed in London and Edinburgh with fuccefs in rheumatic cafes. Frederick Martens, who had opportunity of feeing vaft numbers of thefe birds at Spitzbergen, obferves, that they are very bold, and refort after the whale-fifhers in great flocks; and that, when a whale is taken, they will, in fpite of all endeavours, light on it and pick out large lumps of fat, even when the animal is alive: That the whales are often difcovered at fea by the multitudes of them flying; and that when one of the former are wounded, prodigious multitudes immediately follow its bloody track. He adds, that it is a moft gluttonous bird, eating till it is forced to difgorge itfelf.

2. The puffinus, or fhear-water, is 15 inches in length; the breadth 31; the weight 17 ounces: the bill is an inch and three quarters long; noftrils tubular, but not very prominent: the head, and whole upper fide of the body, wings, tail, and thighs, are of a footy blacknefs; the under fide from chin to tail, and inner coverts of the wings, white: the legs weak, and compreffed fidewife; dufky behind, whitifh before. Thefe birds are found in the Calf of Man; and, as Mr Ray fuppofes, in the Scilly ifles. They refort to the former in February; take a fhort poffeffion of the rabbet-burrows, and then difappear till April. They lay one egg, white and blunt at each end; and the young are fit to be taken the beginning of Auguft; when great numbers are killed by the perfon who farms the ifle: they are falted and barrelled; and when they are boiled, are eaten with potatoes. During the day they keep at fea, fifhing; and towards evening return to their young; whom they feed, by difcharging the contents of their ftomachs into their mouths; which by that time is turned into oil: by reafon of the backward fituation of their legs, they fit quite erect. They quit the ifle the latter end of Auguft, or beginning of September; and, from accounts lately received from navigators, we have reafon to imagine that, like the ftorm-finch, they are difperfed over the whole Atlantic ocean. This fpecies inhabits alfo the Orkney ifles, where it makes its neft in holes on the earth near the fhelves of the rocks and headlands: it is called there the *lyre;* and is much valued, both on account of its being a food, and for its feathers. The inhabitants take and falt them in Auguft for winter provifions, when they boil them with cabbage. They alfo take the old ones in March; but they are then poor, and not fo well tafted as the young: they appear firft in thofe iflands in February.

3. The pelagica, or ftormy petrel, is about the bulk of the houfe-fwallow: the length fix inches; the extent of wings, 13. The whole bird is black, except the coverts of the tail and vent-feathers, which are white: the bill is hooked at the end: the noftrils tubular: the legs flender, and long. It has the fame faculty of fpouting oil from its bill as the other fpecies: and Mr Brunnich tells us, that the inhabitants of the Ferroe ifles make this bird ferve the purpofes of a candle, by drawing a wick through the mouth and rump, which being lighted, the flame is fed by the fat and oil of the body. Except in breeding-time, it is always at fea; and is feen all over the vaft Atlantic ocean, at the greateft diftance

cellaria cefs. diſtance from land; often following the veſſels in great flocks, to pick up any thing that falls from on board: for trial ſake, chopped ſtraw has been flung over, which they would ſtand on with expanded wings; but were never obſerved to ſettle on or ſwim in the water: it preſages bad weather, and cautions the ſeamen of the approach of a tempeſt, by collecting under the ſtern of the ſhips: it braves the utmoſt fury of the ſtorm, ſometimes ſkimming with incredible velocity along the hollows of the waves, ſometimes on the ſummits: Cluſius makes it the Camilla of the ſea.

Vel mare per medium fluctu ſuſpenſa tumenti
Ferret iter, celeres nec tingeret æquore plantas. Virg.

She ſwept the ſeas; and, as ſhe ſkimm'd along,
Her flying feet unbath'd on billows hung. Dryden.

Theſe birds are the *cypſelli* of Pliny, which he places among the *apodes* of Ariſtotle; not becauſe they wanted feet, but were Κακοποδα, or had bad or uſeleſs ones; an attribute he gives to theſe ſpecies, on a ſuppoſition that they were almoſt always on the wing. In Auguſt 1772, Mr Pennant found them on the rocks called *Macdonald's Table*, off the north end of the iſle of Skie; ſo conjectures they breed there. They lurked under the looſe ſtones, but betrayed themſelves by their twittering noiſe.

In Mr White's *Journal of a Voyage to New South Wales* we have a figure of the fuliginous petrel, with a whitiſh beak; which he takes to be a variety of the *Procellaria Æquinoctialis* of Linnæus. It is nearly of the ſize of a raven; its colour is a deep ſooty brown or blackiſh; on the chin there is a ſmall patch of white running down a little on each ſide from the lower mandible; the beak is of yellowiſh white. See Plate CCCCXVI. Captain Bligh, in his *Voyage to the South Seas*, in S. Lat. 60. 1. and W. Long. 71. 45. ſaw both petrels and pintadas; ſome of which he took with baited hooks.

PROCESS, in law, denotes the proceedings in any cauſe, real or perſonal, civil or criminal, from the original writ to the end thereof.

In a more limited ſenſe, proceſs denotes that by which a man is called firſt into any temporal court.

It is the next ſtep for carrying on the ſuit, after ſuing out the original writ. See Suit and Writ.

It is the method taken by the law to compel a compliance with the original writ, of which the primary ſtep is by giving the party notice to obey it. This notice is given upon all real *præcipes;* and alſo upon all perſonal writs for injuries not againſt the peace, by *ſummons;* which is a warning to appear in court at the return of the original writ, given to the defendant by two of the ſheriff's meſſengers called *ſummoners*, either in perſon, or left at his houſe or land: in like manner as in the civil law the firſt proceſs is by perſonal citation, *in jus vocando*. This warning on the land is given, in real actions, by erecting a white ſtick or wand on the defendant's grounds (which ſtick or wand among the northern nations is called the *baculus nunciatorius*), and by ſtatute 31 Eliz. c. 3. the notice muſt alſo be proclaimed on ſome Sunday before the door of the pariſh-church.

Blackſt. Comment.

If the defendant diſobeys this verbal monition, the next proceſs is by writ of *attachment*, or *pone;* ſo called from the words of the writ, *pone per vadium et ſalvos plegios*, "put by gage and ſafe pledges A. B. the defendant," &c. This is a writ not iſſuing out of chancery, but out of the court of common-pleas, being grounded on the non-appearance of the defendant at the return of the original writ; and thereby the ſheriff is commanded to attach him, by taking *gage*, that is, certain of his goods, which he ſhall forfeit if he doth not appear; or by making him find *ſafe pledges* or ſureties, which ſhall be amerced in caſe of his non-appearance. This is alſo the firſt and immediate proceſs, without any previous ſummons, upon actions of treſpaſs *vi et armis*, or for other injuries, which, though not forcible, are yet treſpaſſes againſt the peace, as *deceit* and *conſpiracy;* where the violence of the wrong requires a more ſpeedy remedy, and therefore the original writ commands the defendant to be at once attached, without any precedent warning.

Proceſs.

If, after attachment, the defendant neglects to appear, he not only forfeits this ſecurity, but is moreover to be farther compelled by writ of *diſtringas*, or diſtreſs infinite: which is a ſubſequent proceſs iſſuing from the court of common-pleas, commanding the ſheriff to diſtrain the defendant from time to time, and continually afterwards, by taking his goods and the profits of his lands, which are called *iſſues*, and which he forfeits to the king if he doth not appear. But the iſſues may be ſold, if the court ſhall ſo direct, in order to defray the reaſonable coſts of the plaintiff. In like manner, by the civil law, if the defendant abſconds, ſo that the citation is of no effect, *mittitur adverſarius in poſſeſſionem bonorum ejus*.

And here, by the common as well as the civil law, the proceſs ended in caſe of injuries without force: the defendant if he had any ſubſtance, being gradually ſtripped of it all by repeated diſtreſſes, till he rendered obedience to the king's writ; and, if he had no ſubſtance, the law held him incapable of making ſatisfaction, and therefore looked upon all farther proceſs as nugatory. And beſides, upon feodal principles, the perſon of a feudatory was not liable to be attached for injuries merely civil, leſt thereby his lord ſhould be deprived of his perſonal ſervices. But, in caſes of injury accompanied with force, the law, to puniſh the breach of the peace and prevent its diſturbance for the future, provided alſo a proceſs againſt the defendant's perſon, in caſe he neglected to appear upon the former proceſs of attachment, or had no ſubſtance whereby to be attached; ſubjecting his body to impriſonment by the writ of *capias ad reſpondendum*. But this immunity of the defendant's perſon, in caſe of peaceable though fraudulent injuries, producing great contempt of the law in indigent wrongdoers, a *capias* was alſo allowed, to arreſt the perſon in actions of account, though no breach of the peace be ſuggeſted, by the ſtatutes of Marlbridge, 52 Hen. III. c. 23. and Weſtm. 2. 13 Edw. I. c. 11. in actions of debt and detinue, by ſtatute 25 Edw. III. c. 17. and in all actions on the caſe, by ſtatute 19 Hen. VII c. 9. Before which laſt ſtatute a practice had been introduced of commencing the ſuit by bringing an original writ of treſpaſs *quare clauſum fregit*, by breaking the plaintiff's cloſe, *vi et armis;* which by the old common law ſubjected the defendant's perſon to be arreſted by writ of *capias:* and then afterwards, by connivance of the court, the plaintiff might proceed to proſecute for any other leſs forcible injury. This practice (through cuſtom rather than neceſſity, and for ſaving ſome trouble and expence,

Process.

pence, in suing out a special original adapted to the particular injury) still continues in almost all cases, except in actions of debt; though now, by virtue of the statutes above cited and others, a *capias* might be had upon almost every species of complaint.

If therefore the defendant, being summoned or attached, makes default, and neglects to appear; or if the sheriff returns a *nihil*, or that the defendant hath nothing whereby he may be summoned, attached, or distrained, the *capias* now usually issues: being a writ commanding the sheriff to take the body of the defendant, if he may be found in his bailiwick or county, and him safely to keep, so that he may have him in court on the day of the return, to answer to the plaintiff of a plea of debt, or trespass, &c. as the case may be. This writ, and all others subsequent to the original writ, not issuing out of chancery, but from the court into which the original was returnable, and being grounded on what has passed in that court in consequence of the sheriff's return, are called *judicial*, not *original*, writs; they issue under the private seal of that court, and not under the great seal of England; and are *tested*, not in the king's name, but in that of the chief justice only. And these several writs being grounded on the sheriff's return, must respectively bear date the same day on which the writ immediately preceding was returnable.

This is the regular and orderly method of process. But it is now usual in practice to sue out the *capias* in the first instance, upon a supposed return of the sheriff; especially if it be suspected that the defendant, upon notice of the action, will abscond; and afterwards a fictitious original is drawn up, with a proper return thereupon, in order to give the proceedings a colour of regularity. When this *capias* is delivered to the sheriff, he by his under-sheriff grants a warrant to his inferior officers or bailiffs to execute it on the defendant. And, if the sheriff of Oxfordshire (in which county the injury is supposed to be committed and the action is laid) cannot find the defendant in his jurisdiction, he returns that he is not found, *non est inventus*, in his bailiwick: whereupon another writ issues, called a *testatum capias*, directed to the sheriff of the county where the defendant is supposed to reside, as of Berkshire, reciting the former writ, and that it is testified, *testatum est*, that the defendant lurks or wanders in his bailiwick, where he is commanded to take him, as in the former *capias*. But here also, when the action is brought in one county and the defendant lives in another, it is usual, for saving trouble, time, and expence, to make out a *testatum capias* at the first; supposing not only an original, but also a former *capias*, to have been granted; which in fact never was. And this fiction, being beneficial to all parties, is readily acquiesced in, and is now become the settled practice; being one among many instances to illustrate that maxim of law, that *in fictione juris consistit æquitas*.

But where a defendant absconds, and the plaintiff would proceed to an outlawry against him, an original writ must then be sued out regularly, and after that a *capias*. And if the sheriff cannot find the defendant upon the first writ of *capias*, and returns a *non est inventus*, there issues out an *alias* writ, and after that a *pluries*, to the same effect as the former: only after these words "we command you," this clause is inserted, "as we have formerly," or, "as we have often commanded you;"—"*sicut* alias," or, "*sicut* pluries, *præcepimus*." And if a *non est inventus* is returned upon all of them, then a writ of *exigent* or *exigi facias* may be sued out, which requires the sheriff to cause the defendant to be proclaimed, required, or exacted, in five county-courts successively, to render himself; and if he does, then to take him, as in a *capias*: but if he does not appear, and is returned *quinto exactus*, he shall then be outlawed by the coroners of the county. Also by statute 6 Hen. VIII. c. 4. and 31 Eliz. c. 3. whether the defendant dwells within the same or another county than that wherein the *exigent* is sued out, a *writ of proclamation* shall issue out at the same time with the *exigent*, commanding the sheriff of the county, wherein the defendant dwells, to make three proclamations thereof in places the most notorious, and most likely to come to his knowledge, a month before the outlawry shall take place. Such outlawry is putting a man out of the protection of the law, so that he is incapable to bring an action for redress of injuries; and it is also attended with a forfeiture of all one's goods and chattels to the king. And therefore, till some time after the conquest, no man could be outlawed but for felony: but in Bracton's time, and somewhat earlier, process of outlawry was ordained to lie in all actions for trespasses *vi et armis*. And since, by a variety of statutes (the same which allow the writ of *capias* before-mentioned) process of outlawry doth lie in divers actions that are merely civil; providing they be commenced by original and not by bill. If after outlawry the defendant appears publicly, he may be arrested by a writ of *capias utlagatum*, and committed till the outlawry be reversed. Which reversal may be had by the defendant's appearing personally in court (and in the king's bench without any personal appearance, so that he appears by attorney, according to statute 4 & 5 W. & M. c. 18.) and any plausible cause, however slight, will in general be sufficient to reverse it, it being considered only as a process to compel an appearance. But then the defendant must pay full costs, and put the plaintiff in the same condition as if he had appeared before the writ of *exigi facias* was awarded.

Such is the first process in the court of common pleas. In the king's bench they may also (and frequently do) proceed in certain causes, particularly in actions of ejectment and trespass, by *original* writ, with *attachment* and *capias* thereon; returnable, not at Westminster, where the common pleas are now fixed in consequence of *magna charta*, but *ubicunque fuerimus in Angliâ*, wheresoever the king shall then be in England; the king's bench being removeable into any part of England at the pleasure and discretion of the crown. But the more usual method of proceeding therein is without any original, but by a peculiar species of process intitled a *bill of Middlesex*; and therefore so intitled, because the court now sits in that county; for if it sat in Kent, it would then be a bill of Kent. For though, as the justices of this court have, by its fundamental constitution, power to determine all offences and trespasses, by the common law and custom of the realm, it needed no original writ from the crown to give it cognizance of any misdemesnor in the county wherein it resides; yet as, by this court's coming into any county, it immediately superseded the ordinary administration of justice by the general commissions of *eyre* and of *oyer and terminer*, a process of its own became necessary, within the county where

it sat, to bring in such persons as were accused of committing any forcible injury. The bill of Middlesex (which was formerly always founded on a plaint of trespass *quare clausum fregit*, entered on the records of the court) is a kind of *capias*, directed to the sheriff of that county, and commanding him to take the defendant, and have him before our lord the king at Westminster on a day prefixed, to answer to the plaintiff of a plea of trespass. For this accusation of trespass it is that gives the court of king's bench jurisdiction in other civil causes, since, when once the defendant is taken into custody of the marshal, or prison-keeper of this court, for the supposed trespass, he, being then a prisoner of this court, may here be prosecuted for any other species of injury. Yet, in order to found this jurisdiction, it is not necessary that the defendant be actually the marshal's prisoner; for, as soon as he appears, or puts in bail, to the process, he is deemed by so doing to be in such custody of the marshal as will give the court a jurisdiction to proceed. And, upon these accounts, in the bill or process, a complaint of trespass is always suggested, whatever else may be the real cause of action. This bill of Middlesex must be served on the defendant by the sheriff, if he finds him in that county: but if he returns, *non est inventus*, then there issues out a writ of *latitat*, to the sheriff of another county, as Berks; which is similar to the *testatum capias* in the common pleas, and recites the bill of Middlesex and the proceedings thereon, and that it is testified that the defendant *latitat et discurrit*, lurks and wanders about in Berks; and therefore commands the sheriff to take him, and have his body in court on the day of the return. But as in the common pleas the *testatum capias* may be sued out upon only a supposed, and not an actual preceding, *capias*; so in the king's bench a *latitat* is usually sued out upon only a supposed, and not an actual, bill of Middlesex. So that, in fact, a *latitat* may be called the first process in the court of king's bench, as the *testatum capias* is in the common pleas. Yet, as in the common pleas, if the defendant lives in the county wherein the action is laid, a common *capias* suffices; so in the king's bench likewise, if he lives in Middlesex, the process must still be by bill of Middlesex only.

In the exchequer the first process is by writ of *quo minus*, in order to give the court a jurisdiction over pleas between party and party. In which writ the plaintiff is alleged to be the king's farmer or debtor, and that the defendant hath done him the injury complained of, *quo minus sufficiens existit*, by which he is the less able to pay the king his rent or debt. And upon this the defendant may be arrested as upon a *capias* from the common pleas.

Thus differently do the three courts set out at first, in the commencement of a suit, in order to intitle the two courts of king's bench and exchequer to hold plea in subjects causes, which by the original constitution of Westminster-hall they were not empowered to do. Afterwards, when the cause is once drawn into the respective courts, the method of pursuing it is pretty much the same in all of them.

If the sheriff had found the defendant upon any of the former writs, the *capias latitat*, &c. he was anciently obliged to take him into custody, in order to produce him in court upon the return, however small and minute the cause of action might be. For, not having obeyed the original summons, he had shown a contempt of the court, and was no longer to be trusted at large. But when the summons fell into disuse, and the *capias* became in fact the first process, it was thought hard to imprison a man for a contempt which was only supposed: and therefore, in common cases, by the gradual indulgence of the courts (at length authorised by statute 12 Geo. I. c. 29. which was amended by statute 5 Geo. II. c. 27. and made perpetual by statute 21 Geo. II. c. 3.) the sheriff or his officer can now only personally serve the defendant with the copy of the writ or process, and with notice in writing to appear by his attorney in court to defend this action; which in effect reduces it to a mere summons. And if the defendant thinks proper to appear upon this notice, his appearance is recorded, and he puts in sureties for his future attendance and obedience; which sureties are called *common bail*, being the same two imaginary persons that were pledges for the plaintiff's prosecution, John Doe and Richard Roe. Or, if the defendant does not appear upon the return of the writ, or within four (or in some cases eight) days after, the plaintiff may enter an appearance for him, as if he had really appeared; and may file common bail in the defendant's name, and proceed thereupon as if the defendant had done it himself.

But if the plaintiff will make affidavit, or assert upon oath, that the cause of action amounts to ten pounds or upwards, then in order to arrest the defendant, and make him put in substantial sureties for his appearance, called *special bail*, it is required by statute 13 Car. II. stat. 2. c. 2. that the true cause of action should be expressed in the body of the writ or process: else no security can be taken in a greater sum than L. 40. This statute (without any such intention in the makers) had like to have ousted the king's bench of all its jurisdiction over civil injuries without force: for, as the bill of Middlesex was framed only for actions of trespass, a defendant could not be arrested and held to bail thereupon for breaches of civil contracts. But to remedy this inconvenience, the officers of the king's bench devised a method of adding what is called a clause of *ac etiam* to the usual complaint of trespass; the bill of Middlesex commanding the defendant to be brought in to answer the plaintiff of a plea of trespass, *and also* to a bill of debt: the complaint of trespass giving cognizance to the court, and that of debt authorising the arrest. In imitation of which, lord chief justice North, a few years afterwards, in order to save the suitors of his court the trouble and expence of suing out special originals, directed, that in the common pleas, besides the usual complaint of breaking the plaintiff's close, a clause of *ac etiam* might be also added to the writ of *capias*, containing the true cause of action; as, "that the said Charles the defendant may answer to the plaintiff of a plea of trespass in breaking his close: and also, *ac etiam* may answer him, according to the custom of the court, in a certain plea of trespass upon the case, upon promises, to the value of L. 20, &c." The sum sworn to by the plaintiff is marked upon the back of the writ; and the sheriff, or his officer the bailiff, is then obliged actually to arrest or take into custody the body of the defendant, and, having so done, to return the writ with a *cepi corpus* indorsed thereon. See Arrest.

When the defendant is regularly arrested, he must either

Process.

either go to prison, for safe custody; or put in *special bail* to the sheriff. For, the intent of the arrest being only to compel an appearance in court at the return of the writ, that purpose is equally answered, whether the sheriff detains his person, or takes sufficient security for his appearance, called *bail* (from the French word *bailler*, "to deliver)," because the defendant is bailed, or delivered, to his sureties, upon their giving security for his appearance; and is supposed to continue in their friendly custody instead of going to gaol. See Bail. The method of putting in bail to the sheriff is by entering into a bond or obligation, with one or more sureties, (not fictitious persons, as in the former case of common bail, but real, substantial, responsible bondsmen), to insure the defendant's appearance at the return of the writ; which obligation is called the *bail-bond*. The sheriff, if he pleases, *may* let the defendant go without any sureties; but that is at his own peril: for, after once taking him, the sheriff is bound to keep him safely, so as to be forthcoming in court; otherwise an action lies against him for an escape. But, on the other hand, he is obliged, by statute 23 Hen. VI. c. 10. to take (if it be tendered) a sufficient bail-bond; and, by statute 12 Geo. I. c. 29. the sheriff shall take bail for no other sum than such as is sworn to by the plaintiff, and indorsed on the back of the writ.

Upon the return of the writ, or within four days after, the defendant must *appear* according to the exigency of the writ. This *appearance* is effected by putting in and justifying bail *to the action*; which is commonly called *putting in bail above*. If this be not done, and the bail that were taken by the sheriff *below* are responsible persons, the plaintiff may take an assignment from the sheriff of the bail-bond (under the statute 4 & 5 Ann. c. 16.) and bring an action thereupon against the sheriff's bail. But if the bail so accepted by the sheriff be insolvent persons, the plaintiff may proceed against the sheriff himself, by calling upon him, first to return the writ (if not already done), and afterwards to bring in the body of the defendant. And if the sheriff does not then cause sufficient bail to be put in *above*, he will himself be responsible to the plaintiff.

The bail *above*, or bail *to the action*, must be put in either in open court, or before one of the judges thereof; or else, in the country, before a commissioner appointed for that purpose by virtue of the statute 4 W. & M. c. 4 which must be transmitted to the court. These bail, who must at least be two in number, must enter into a recognizance in court, or before the judge or commissioner, whereby they do jointly and severally undertake, that if the defendant be condemned in the action, he shall pay the costs and condemnation, or render himself a prisoner, or that they will pay it for him: which recognizance is transmitted to the court in a slip of parchment, intitled a *bail-piece*. And, if required, the bail must *justify* themselves in court, or before the commissioner in the country, by swearing themselves housekeepers, and each of them to be worth double the sum for which they are bail, after payment of all their debts. This answers in some measure to the *stipulatio* or *satisdatio* of the Roman laws, which is mutually given by each litigant party to the other: by the plaintiff that he will prosecute his suit, and pay the costs if he loses his cause; in like manner as our law still requires nominal pledges of prosecution from the plaintiff: by the defendant, that he shall continue in court, and abide the sentence of the judge, much like our special bail; but with this difference, that the *fidejussores* were there absolutely bound *judicatum solvere*, to see the costs and condemnation paid at all events: whereas our special bail may be discharged, by surrendering the defendant into custody within the time allowed by law; for which purpose they are at all times intitled to a warrant to apprehend him.

Special bail is required (as of course) only upon actions of debt, or actions on the case in trover, or for money due, where the plaintiff can swear that the cause of action amounts to ten pounds: but in actions where the damages are precarious, being to be assessed *ad libitum* by a jury, as in actions for words, ejectment, or trespass, it is very seldom possible for a plaintiff to swear to the amount of his cause of action; and therefore no special bail is taken thereon, unless by a judge's order, or the particular directions of the court, in some peculiar species of injuries, as in cases of mayhem or atrocious battery; or upon such special circumstances as make it absolutely necessary that the defendant should be kept within the reach of justice. Also in actions against heirs, executors, and administrators, for debts of the deceased, special bail is not demandable; for the action is not so properly against them in person, as against the effects of the deceased in their possession. But special bail is required even of them, in actions for a *devastavit*, or wasting the goods of the deceased; that wrong being of their own committing.

Thus much for *process*; which is only meant to bring the defendant into court, in order to contest the suit, and abide the determination of the law. When he appears either in person as a prisoner, or out upon bail, then follow the *pleadings* between the parties. See Pleadings.

Process upon an Indictment. See Prosecution. The proper process on an indictment for any petty misdemesnor, or on a penal statute, is a writ of *venire facias*, which is in the nature of a summons to cause the party to appear. And if by the return to such *venire* it appears that the party hath lands in the county whereby he may be distrained, then a *distress infinite* shall be issued from time to time till he appears. But if the sheriff returns, that he hath no lands in his bailiwick, then (upon his non-appearance) a writ of *capias* shall issue, which commands the sheriff to take his body, and have him at the next assises; and if he cannot be taken upon the first *capias*, a second and a third shall issue, called an *alias*, and a *pluries capias*. But, on indictments for treason or felony, a *capias* is the first process: and, for treason or homicide, only one shall be allowed to issue, or two in the case of other felonies, by statute 25 Edw. III. c. 14. though the usage is to issue only one in any felony; the provisions of this statute being in most cases found impracticable. And so, in the case of misdemesnors, it is now the usual practice for any judge of the court of king's bench, upon certificate of an indictment found, to award a writ of *capias* immediately, in order to bring in the defendant. But if he absconds, and it is thought proper to pursue him to an outlawry, then a greater exactness is necessary. For, in such case, after the several writs have issued in a regular number, according to the nature of the re-

fpective crimes, without any effect, the offender fhall be put in the *exigent* in order to his outlawry: that is, he fhall be exacted, proclaimed, or required, to furrender, at five county-courts; and if he be returned *quinto exactus*, and does not appear at the fifth exaction or requifition, then he is adjudged to be *outlawed*, or put out of the protection of the law; fo that he is incapable of taking the benefit of it in any refpect, either by bringing actions or otherwife.

The punifhment, for outlawries upon indictments for mifdemefnors, is the fame as for outlawries upon civil actions; viz. forfeiture of goods and chattels. But an outlawry in treafon or felony amounts to a conviction and attainder of the offence charged in the indictment, as much as if the offender had been found guilty by his country. His life is, however, ftill under the protection of the law, as hath elfewhere been obferved; (fee Homicide): that though anciently an outlawed felon was faid to have *caput lupinum*, and might be knocked on the head like a wolf, by any one that fhould meet him; becaufe, having renounced all law, he was to be dealt with as in a ftate of nature, when every one that fhould find him might flay him: yet now, to avoid fuch inhumanity, it is holden that no man is intitled to kill him wantonly or wilfully; but in fo doing is guilty of murder, unlefs it happens in the endeavour to apprehend him. For any perfon may arreft an outlaw on a criminal profecution, either of his own head, or by writ or warrant of *capias utlagatum*, in order to bring him to execution. But fuch outlawry may be frequently reverfed by writ of error, the proceedings therein being (as it is fit they fhould be) exceedingly nice and circumftantial; and if any fingle minute point be omitted or mifconducted, the whole outlawry is illegal, and may be reverfed: upon which reverfal the party accufed is admitted to plead to, and defend himfelf againft, the indictment.

Thus much for procefs to bring in the offender after indictment found; during which ftage of the profecution it is that writs of *certiorari facias* are ufually had, though they may be had at any time before trial, to certify and remove the indictment, with all the proceedings thereon, from any inferior court of criminal jurifdiction into the court of king's bench; which is the fovereign ordinary court of juftice in caufes criminal. And this is frequently done for one of thefe four purpofes; either, 1. To confider and determine the validity of appeals or indictments and the proceedings thereon; and to quafh or confirm them as there is caufe; or, 2. Where it is furmifed that a partial or infufficient trial will probably be had in the court below, the indictment is removed, in order to have the prifoner or defendant tried at the bar of the court of king's bench, or before the juftices of *nifi prius*: or, 3. It is fo removed, in order to plead the king's pardon there: or, 4. To iffue procefs of outlawry againft the offender, in thofe counties or places where the procefs of the inferior judges will not reach him. Such writ of *certiorari*, when iffued and delivered to the inferior court for removing any record or other proceeding, as well upon indictment as otherwife, fuperfedes the jurifdiction of fuch inferior court, and makes all fubfequent proceedings therein entirely erroneous and illegal; unlefs the court of king's bench remands the record to the court below, to be there tried and determined. A *certiorari* may be granted at the inftance of either the profecutor or the defendant: the former as a matter of right, the latter as a matter of difcretion; and therefore it is feldom granted to remove indictments from the juftices of gaol-delivery, or after iffue joined, or confeffion of the fact in any of the courts below.

At this ftage of profecution alfo it is, that indictments found by the grand jury againft a peer, muft, in confequence of a writ of *certiorari*, be certified and tranfmitted into the court of parliament, or into that of the lord high fteward of Great Britain; and that, in places of exclufive jurifdiction, as the two univerfities, indictments muft be delivered (upon challenge and claim of cognizance) to the courts therein eftablifhed by charter, and confirmed by act of parliament, to be there refpectively tried and determined. See Plea.

Process, in chemiftry, the whole courfe of an experiment or feries of operations, tending to produce fomething new.

Process, in anatomy, denotes any protuberance or eminence in a bone.

PROCESSION, a ceremony in the Romifh church, confifting of a formal march of the clergy and people, putting up prayers, &c. and in this manner vifiting fome church, &c. They have alfo proceffions of the hoft or facrament, &c. See Host.

PROCHEIN amy, in law, the perfon next akin to a child in non-age, and who, in that refpect, is allowed to act for him, and be his guardian, &c. if he hold land in foccage.

To fue, an infant is not allowed to make an attorney; but the court will admit his next friend as plaintiff, or his guardian as defendant.

PROCKIA, in botany: A genus of the monogynia order, belonging to the polyandria clafs of plants; and in the natural method ranking with thofe of which the order is doubtful. The calyx is triphyllous, befides two leafets at the bafe. There is no corolla; the berry is quinqueangular, and polyfpermous.

PROCLAMATION, a public notice given of any thing of which the king thinks proper to advertife his fubjects.

Proclamations are a branch of the king's prerogative *; and have then a binding force, when (as Sir Edward Coke obferves) they are grounded upon and enforce the laws of the realm. For, though the making of laws is entirely the work of a diftinct part, the legiflative branch of the fovereign power, yet the manner, time, and circumftances of putting thofe laws in execution, muft frequently be left to the difcretion of the executive magiftrate. And therefore his conftitutions or edicts, concerning thofe points which we call *proclamations*, are binding upon the fubject, where they do not either contradict the old laws, or tend to eftablifh new ones; but only enforce the execution of fuch laws as are already in being, in fuch manner as the king fhall judge neceffary. Thus the eftablifhed law is, that the king may prohibit any of his fubjects from leaving the realm: a proclamation therefore forbidding this in general for three weeks, by laying an embargo upon all fhipping in time of war, will be equally binding as an act of parliament, becaufe founded upon a prior law. But a proclamation to lay an embargo in time of peace upon all veffels laden with wheat, (though in the time of a public fcarcity), being contrary to law, and

* See *Prerogative*.

and particularly to statute 22 Car. II. c. 13. the advisers of such a proclamation, and all persons acting under it, found it necessary to be indemnified by a special act of parliament, 7 Geo. III. c. 7. A proclamation for disarming Papists is also binding, being only in execution of what the legislature has first ordained: but a proclamation for allowing arms to Papists, or for disarming any Protestant subjects, will not bind; because the first would be to assume a dispensing power, the latter a legislative one; to the vesting of either of which in any single person the laws of England are absolutely strangers. Indeed, by the statute 31 Hen. VIII. c. 8. it was enacted, that the king's proclamations should have the force of acts of parliament: a statute, which was calculated to introduce the most despotic tyranny; and which must have proved fatal to the liberties of this kingdom, had it not been luckily repealed in the minority of his successor, about five years after. By a late act of parliament the king is empowered to raise regiments of Roman Catholics, to serve in the present war.

PROCLUS, surnamed DIADOCUS, a Greek philosopher and mathematician, was born in Lycia, and lived about the year 500. He was the disciple of Syrianus, and had a great share in the friendship of the emperor Anastasius. It is said, that when Vitalian laid siege to Constantinople, Proclus burnt his ships with large brazen speculums. This philosopher was a Pagan, and wrote against the Christian religion. There are still extant his Commentaries on some of Plato's books, and other of his works written in Greek.

PROCONSUL, a Roman magistrate, sent to govern a province with consular authority.

The proconsuls were appointed out of the body of the senate; and usually as the year of any one's consulate expired, he was sent proconsul into some province.

The proconsuls decided cases of equity and justice, either privately in their pretorium or palace, where they received petitions, heard complaints, granted writs under their seal, and the like; or else publicly, in the common hall, with the usual formalities observed in the court of judicature at Rome. They had besides, by virtue of their edicts, the power of ordering all things relating to the tribunes, taxes, contributions, and provisions of corn and money, &c. Their office lasted only a year. See CONSUL.

PROCOPIUS, a famous Greek historian, born in Cæsaria, acquired great reputation by his works in the reign of Justinian, and was secretary to Belisarius during all the wars carried on by that general in Persia, Africa, and Italy. He at length became senator, obtained the title of *illustrious*, and was made pretor of Constantinople.

PROCREATION, the begetting and bringing forth young. See GENERATION and SEMEN.

PROCTOR, a person commissioned to manage another person's cause in any court of the civil or ecclesiastical law.

PROCTOR, in the English universities. See UNIVERSITY.

PROCURATION, an act or instrument by which a person is empowered to treat, transact, receive, &c. in another person's name.

PROCURATOR. See PROCTOR.

PRODIGALITY, means extravagance, profusion, waste, or excessive liberality, and is the opposite extreme to the vice of parsimony. By the Roman law, if a man by notorious prodigality was in danger of wasting his estate, he was looked upon as *non compos*, and committed to the care of curators, or tutors, by the prætor. And by the laws of Solon, such prodigals were branded with perpetual infamy.

PRODUCT, in arithmetic and geometry, the factum of two or more numbers, or lines, &c. into one another: thus $5\times4=20$ the product required.

PROEDRI, among the Athenians, were magistrates, who had the first seats at the public assemblies, and whose office it was to propose at each assembly the things to be deliberated upon and determined. Their office always ended with the meeting. Their number was nine, so long as the tribes were ten in number.

PROFANATION, the acting disrespectfully to sacred things.

PROFANE, a term used in opposition to *holy*; and in general is applied to all persons who have not the sacred character, and to things which do not belong to the service of religion.

PROFESSION means a calling, vocation, or known employment. In Knox's *Essays*, vol. 1st, page 234, we find an excellent paper on the choice of a profession, which that elegant writer concludes thus: "All the occupations of life (says he) are found to have their advantages and disadvantages admirably adapted to preserve the just equilibrium of happiness. This we may confidently assert, that, whatever are the inconveniences of any of them, they are all preferable to a life of inaction; to that wretched listlessness, which is constrained to pursue pleasure as a business, and by rendering it the object of severe and unvaried attention, destroys its very essence."

Among the Romanists profession denotes the entering into a religious order, whereby a person offers himself to God by a vow of inviolably observing obedience, chastity, and poverty.

PROFESSOR, in the universities, a person who teaches or reads public lectures in some art or science from a chair for the purpose.

PROFILE, in architecture, the draught of a building, fortification, &c. wherein are expressed the several heights, widths, and thicknesses, such as they would appear were the building cut down perpendicularly from the roof to the foundation. Whence the profile is also called the *section*, sometimes *orthographical section*, and by Vitruvius also *sciagraphy*.

Profile, in this sense, amounts to the same with *elevation*; and stands opposed to a *plan* or *ichnography*.

PROFILE is also used for the contour or out-line of a figure, building, member of architecture, or the like; as a base, a cornice, &c. Hence *profiling* is sometimes used for designing, or describing the member with rule, compass, &c.

PROFILE, in sculpture and painting.—A head, a portrait, &c. are said to be in *profile*, when they are represented sidewise, or in a side-view; as, when in a portrait there is but one side of the face, one eye, one cheek, &c. shown, and nothing of the other.—On almost all medals, the faces are represented in *profile*.

PROFLUVIUM, in medicine, denotes a flux, or liquid evacuation of any thing.

PROGNOSTIC, among physicians, signifies a judgement concerning the event of a disease, as whether it shall end in life or death, be short or long, mild or malignant, &c.

PROGRAMMA, anciently signified a letter sealed with the king's seal.

Programma is also an university term for a billet or advertisement, posted up or given into the hand, by way of invitation to an oration, &c. containing the argument, or so much as is necessary for understanding thereof.

PROGRESSION, in general, denotes a regular advancing, or going forward, in the same course and manner. Progression.

PROGRESSION, in mathematics, is either arithmetical or geometrical. Continued arithmetic proportion is, where the terms do increase and decrease by equal differences, and is called *arithmetic progression*:

$$\text{Thus}\left\{\begin{array}{l} a,\ a+d,\ a+2d,\ a+3d,\ \text{\&c. increasing} \\ a,\ a-d,\ a-2d,\ a-3d,\ \text{\&c. decreasing}\end{array}\right\}\text{by the difference } d.$$

$$\text{In numbers}\left\{\begin{array}{l} 2,\ 4,\ 6,\ 8,\ 10,\ \text{\&c. increasing} \\ 10,\ 8,\ 6,\ 4,\ 2,\ \text{\&c. decreasing}\end{array}\right\}\text{by the difference } 2.$$

Geometric Progression, or *Continued Geometric Proportion*, is when the terms do increase or decrease by equal ratios: thus,

$$\left.\begin{array}{l} a,\ ar,\ arr,\ arrr,\ \text{\&c. increasing} \\ a,\ \frac{a}{r},\ \frac{a}{rr},\ \frac{a}{rrr},\ \text{\&c. decreasing}\end{array}\right\}\text{from a continual}\left\{\begin{array}{l}\text{multiplication}\\ \text{division}\end{array}\right\}\text{by } r.$$

$$\left.\begin{array}{l} 2,\ 4,\ 8,\ 16,\ 32,\ 64,\ \text{increasing} \\ 64,\ 32,\ 16,\ 8,\ 4,\ 2,\ \text{decreasing}\end{array}\right\}\text{from a continual}\left\{\begin{array}{l}\text{multiplication}\\ \text{division}\end{array}\right\}\text{by } 2.$$

See the articles FLUXIONS, GEOMETRY, and SERIES.

PROJECTILES.

1 THIS is the name for that part of mechanical philosophy which treats of the motion of bodies any how projected from the surface of this earth, and influenced by the action of terrestrial gravity.

2 It is demonstrated in the physical part of astronomy that a body so projected must describe a conic section, having the centre of the earth in one focus; and that it will describe round that focus areas proportional to the times. And it follows from the principles of that science, that if the velocity of projection exceeds 36700 feet in a second, the body (if not resisted by the air) would describe a hyperbola; if it be just 36700, it would describe a parabola; and if it be less than this, it would describe an ellipsis. If projected directly upwards, in the first case, it would never return, but proceed for ever; its velocity continually diminishing, but never becoming less than an assignable portion of the excess of the initial velocity above 36700 feet in a second; in the second case, it would never return, its velocity would diminish without end, but never be extinguished. In the third case, it would proceed till its velocity was reduced to an assignable portion of the difference between 36700 and its initial velocity; and would then return, regaining its velocity by the same degrees, and in the same places, as it lost it. These are necessary consequences of a gravity directed to the centre of the earth, and inversely proportional to the square of the distance. But in the greatest projections that we are able to make, the gravitations are so nearly equal, and in directions so nearly parallel, that it would be ridiculous affectation to pay any regard to the deviations from equality and parallelism. A bullet rising a mile above the surface of the earth loses only $\frac{1}{1000}$ of its weight, and a horizontal range of 4 miles makes only 4′ of deviation from parallelism.

Let us therefore assume gravitation as equal and parallel. The errors arising from this assumption are quite insensible in all the uses which can be made of this theory.

The theory itself will ever be regarded with some veneration and affection by the learned. It was the first fruits of mathematical philosophy. Galileo was the first who applied mathematical knowledge to the motions of free bodies, and this was the subject on which he exercised his fine genius.

Gravity must be considered by us as a constant or uniform accelerating or retarding force, according as it produces the descent, or retards the ascent, of a body. 3 Constant or uniform.
A constant or invariable accelerating force is one which produces an uniform acceleration; that is, which in equal times produces equal increments of velocity, and therefore produces increments of velocity proportional to the times in which they are produced. Forces are of themselves imperceptible, and are seen only in their effects; and they have no measure but the effect, or what *measures* the effect; and every thing which we can discover with regard to those measures, we must affirm with regard to the things of which we assume them as the measures. Therefore,

The motion of a falling body, or of a body projected directly downwards, is uniformly accelerated; and that of a body projected directly upwards is uniformly retarded: that is, the acquired velocities are as the times in which they are acquired by falling, and the extinguished velocities are as the times in which they are extinguished. 4 Consequences of this fact.

Cor. 1. If bodies simply fall, not being projected downwards by any external force, the times of the falls are proportional to the final velocities; and the times of ascents, which terminate by the action of gravity alone, are proportional to the initial velocities. 5 Corollaries drawn from it.

2. The spaces described by a heavy body falling from rest are as the squares of the acquired velocities; and the differences of these spaces are as the differences of the squares of the acquired velocities: and, on the other hand, the heights to which bodies projected upwards will rise, before their motions be extinguished, are as the squares of the initial velocities.

3. The spaces described by falling bodies are proportional to the squares of the times from the beginning of the fall; and the spaces described by bodies projected directly upwards are as the squares of the times of the ascents.

4. The space described by a body falling from rest is one half of the space which the body would have uniformly described in the same time, with the velocity acquired

quired by the fall.—And the height to which a body will rife, in oppofition to the action of gravity, is one half of the fpace which it would uniformly defcribe in the fame time with the initial velocity.

In like manner the difference of the fpaces which a falling or rifing body defcribes in any equal fucceffive parts of its fall or rife, is one half of the fpace which it would uniformly defcribe in the fame time with the difference of the initial and final velocities.

This propofition will be more conveniently expreffed for our purpofe thus:

A body moving uniformly during the time of any fall with the velocity acquired thereby, will in that time defcribe a fpace double of that fall; and a body projected directly upwards will rife to a height which is one half of the fpace which it would, uniformly continued, defcribe in the time of its afcent with the initial velocity of projection.

Thefe theorems have been already demonftrated in a popular way, in the article MECHANICS, fect. vi. § 14, 15, 16, &c. and in GUNNERY. But we would recommend to our readers the 39th prop. of the firft book of Newton's *Principia*, as giving the moft general inveftigation of this fubject; equally eafy with thefe more loofe methods of demonftration, and infinitely fuperior to them, by being equally applicable to every variation of the accelerating force. See an excellent application of this propofition by Mr Robins, for defining the motion of a ball difcharged from a cannon, in the article GUNNERY, n° 15. See another in OPTICS, n° 127. for defining the motion of light in refraction, &c.

6
The force of gravity in falling bodies can be afcertained.

5. It is a matter of obfervation and experience, that a heavy body falls 16 feet and an inch Englifh meafure in a fecond of time; and therefore acquires the velocity of 32 feet 2 inches *per* fecond. This cannot be afcertained directly, with the precifion that is neceffary. A fecond is too fmall a portion of time to be exactly meafured and compared with the fpace defcribed; but it is done with the greateft accuracy by comparing the motion of a falling body with that of a pendulum. The time of a vibration is to the time of falling through half the length of the pendulum, as the circumference of a circle is to its diameter. The length of a pendulum can be afcertained with great precifion; and it can be lengthened or fhortened till it makes juft 86,400 vibrations in a day: and this is the way in which the fpace fallen through in a fecond has been accurately afcertained.

As all other forces are afcertained by the accelerations which they produce, they are conveniently meafured by comparing their accelerations with the acceleration of gravity. This therefore has been affumed by all the later and beft writers on mechanical philofophy, as the unit by which every other force is meafured. It gives us a perfectly diftinct notion of the force which retains the moon in its orbit, when we fay it is the 3600th part of the weight of the moon at the furface of the earth. We mean by this, that if a bullet were here weighed by a fpring fteel-yard, and pulled it out to the mark 3600; if it were then taken to the diftance of the moon, it would pull it out only to the mark 1. And we make this affertion on the authority of our having obferved that a body at the diftance of the moon falls from that diftance $\frac{1}{3600}$ part of 16 feet in a fecond. We do not, therefore, compare the *forces*, which are imperceptible things; we compare the accelerations, which are their indications, effects, and meafures.

Two ... of determining fall of heavy bodies.

This has made philofophers fo anxious to determine with precifion the fall of heavy bodies, in order to have an exact value of the accelerating power of terreftrial gravity. Now we muft here obferve, that this meafure may be taken in two ways: we may take the fpace through which the heavy body falls in a fecond; or we may take the velocity which it acquires in confequence of gravity having acted on it during a fecond. The laft is the proper meafure; for the laft is the immediate effect on the body. The action of gravity has changed the ftate of the body—in what way? by giving it a determination to motion downward: this both points out the kind and the degree or intenfity of the force of gravity. The fpace defcribed in a fecond by falling, is not an invariable meafure; for, in the fucceffive feconds, the body falls through 16, 48, 80, 112, &c. feet, but the changes of the bodies ftate in each fecond is the fame. At the beginning it had no determination to move with any appreciable velocity; at the end of the firft fecond it had a determination by which it would have gone on for ever (had no fubfequent force acted on it) at the rate of 32 feet *per* fecond. At the end of the fecond fecond, it had a determination by which it would have moved for ever, at the rate of 64 feet *per* fecond. At the end of the third fecond, it had a determination by which it would have moved for ever, at the rate of 96 feet *per* fecond, &c. &c. The difference of thefe determinations is a determination to the rate of 32 feet *per* fecond. This is therefore conftant, and the indication and proper meafure of the conftant or invariable force of gravity. The fpace fallen through in the firft fecond is of ufe only as it is one half of the meafure of this determination; and as halves have the proportion of their wholes, different accelerating forces may be fafely affirmed to be in the proportion of the fpaces through which they uniformly impel bodies in the fame time. But we fhould always recollect, that this is but one half of the true meafure of the accelerating force. Mathematicians of the firft rank have committed great miftakes by not attending to this; and it is neceffary to notice it juft now, becaufe cafes will occur in the profecution of this fubject, where we fhall be very apt to confound our reafonings by a confufion in the ufe of thofe meafures. Thofe mathematicians who are accuftomed to the geometrical confideration of curvilineal motions, are generally difpofed to take the *actual deflection* from the tangent as the meafure of the deflecting force; while thofe who treat the fame fubject algebraically, by the affiftance of fluxions, take *the change of velocity*, which is meafured by *twice* the deflection. The reafon is this: when a body paffes through the point B of a curve ABC, fig. 1. if the deflecting force were to ceafe at that inftant, the body would defcribe the tangent BD in the fame time in which it defcribes the arch BC of the curve, and DC is the deflection, and is therefore taken for the meafure of the deflecting force. But the algebraift is accuftomed to confider the curve by means of an equation between the abfciffæ H *a*, H *b*, H *c*, and their refpective ordinates A*a*, B*b*, C*c*; and he meafures the deflections by the changes made on the increments of the ordinates. Thus the increment of the ordinate A*a*, while the body defcribes the arch AB of the curve, is BG. If the deflecting force were to ceafe

ceaſe when the body is at B, the next increment would have been equal to BG, that is, it would have been EF; but, in conſequence of the deflection, it is only CF: therefore he takes EC for the meaſure of the deflection, and of the deflecting force. Now EC is ultimately twice DC; and thus the meaſure of the algebraiſt (derived ſolely from the nature of the differential method, and without any regard to phyſical conſiderations) happens to coincide with the true phyſical meaſure. There is therefore great danger of mixing theſe meaſures. Of this we cannot give a more remarkable inſtance than Leibnitz's attempt to demonſtrate the elliptical motion of the planets in the Leipſic Acts, 1689. He firſt conſiders the ſubject mechanically, and takes the deflection or DC for the meaſure of the deflecting force. He then introduces his differential calculus, where he takes the difference of the increments for the meaſure; and thus brings himſelf into a confuſion, which luckily compenſates for the falſe reaſoning in the preceding part of his paper, and gives his reſult the appearance of a demonſtration of Newton's great diſcovery, while, in fact, it is a confuſed jumble of aſſumptions, ſelf-contradictory, and inconſiſtent with the very laws of mechanics which are uſed by him in the inveſtigation. Seventeen years after this, in 1706, having been criticiſed for his bad reaſoning, or rather accuſed of an envious and unſucceſsful attempt to appropriate Newton's inventions to himſelf, he gives a correction of his paralogiſm, which he calls a correction of language. But he either had not obſerved where the paralogiſm lay, or would not let himſelf down by acknowledging a miſtake in what he wiſhed the world to think his own calculus (fluxions); he applied the correction where no fault had been committed, for he had meaſured both the centrifugal force and the ſolicitation of gravity in the ſame way, but had applied the fluxionary expreſſion to the laſt and not to the firſt, and, by ſo doing, he completely deſtroyed all coincidence between his reſult and the planetary motions. We mention this inſtance, not only as a caution to our mathematical readers, but alſo as a very curious literary anecdote. This diſſertation of Leibnitz is one of the moſt obſcure of his obſcure writings, but deſerves the attention of an intelligent and curious reader, and cannot fail of making an indelible impreſſion on his mind, with relation to the modeſty, candour, and probity of the author. It is preceded by a diſſertation on the ſubject which we are now entering upon, the motion of projectiles in a reſiſting medium. Newton's *Principia* had been publiſhed a few years before, and had been reviewed, in a manner ſhamefully ſlight, in the Leipſic Acts. Both theſe ſubjects make the capital articles of that immortal work. Mr Leibnitz publiſhed theſe diſſertations, without (ſays he) having ſeen Newton's book, in order to ſhow the world that he had, ſome years before, diſcovered the ſame theorems. Mr Nicholas Fatio carried a copy of the *Principia* from the author to Hanover in 1686, where he expected to find Mr Leibnitz; he was then abſent, but Fatio ſaw him often before his return to France in 1687, and does not ſay that the book was not given him. Read along with theſe diſſertations Dr Keill's letter to John Bernoulli and others, publiſhed in the *Journal Literaire de la Hayée* 1714, and to John Bernoulli in 1719.

9 ticular- f Leib-

10 Newton accuſed of a ſimilar miſtake by J. Bernoulli,

Newton has been accuſed of a ſimilar overſight by John Bernoulli, (who indeed calls it a miſtake in principle) in his Propoſition X. Book 2. on the very ſubject we are now conſidering. But Dr Keill has ſhown it to be only an overſight, in drawing the tangent on the wrong ſide of the ordinate. For in this very propoſition Newton exhibits, in the ſtricteſt and moſt beautiful manner, the difference between the geometrical and algebraical manner of conſidering the ſubject; and expreſsly warns the reader, that *his* algebraical ſymbol expreſſes the deflection only, and not the variation of the increment of the ordinate. It is therefore in the laſt degree improbable that he would make this miſtake. He moſt expreſsly does not; and as to the real miſtake, which he corrected in the ſecond edition, the writer of this article has in his poſſeſſion a manuſcript copy of notes and illuſtrations on the whole Principia, written in 1693 by Dr David Gregory, Savilian profeſſor of aſtronomy at Oxford, at the deſire of Mr Newton, as preparatory for a new edition, where he has rectified this and ſeveral other miſtakes in that work, and ſays that Mr Newton had ſeen and approved of the amendments.

11 But falſely.

12 Inſincerity of Bernoulli with reſpect to Newton.

We mention theſe particulars, becauſe Mr Bernoulli publiſhed an elegant diſſertation on this ſubject in the Leipſic Acts in 1713; in which he charges Newton (though with many proteſtations of admiration and reſpect) with this miſtake in principle; and ſays, that he communicated his correction to Mr Newton by his nephew Nicholas Bernoulli, that it might be corrected in the new edition, which he heard was in the preſs. And he afterwards adds, that it appears by ſome ſheets being cancelled, and new ones ſubſtituted in this part of the work, that the miſtake would have continued, had he not corrected it. We would deſire our readers to conſult this diſſertation, which is extremely elegant, and will be of ſervice to us in this article; and let them compare the civil things which is here ſaid of the *vir incomparabilis*, the *omni laude major*, the *ſummus Newtonus*, with what the ſame author, in the ſame year, in the Leipſic Acts, but under a borrowed name, ſays of him. Our readers will have no heſitation in aſcribing this letter to this author. For, after praiſing John Bernoulli as *ſummus geometra, natus ad ſummorum geometrarum paralogiſmos corrigendos, ſummi candoris ut et modeſtiæ*, he betrays himſelf by an unguarded warmth, when defending J. B.'s demonſtration of the inverſe problem of centripetal forces, by calling it MEAM *demonſtrationem*.

Let our readers now conſider the ſcope and intention of this diſſertation on projectiles, and judge whether the author's aim was to inſtruct the world, or to acquire fame, by correcting Newton. The diſſertation does not contain one theorem, one corollary, nor one ſtep of argument, which is not to be found in Newton's firſt edition; nor has he gone farther than Newton's ſingle propoſition the Xth. To us it appears an exact companion to his propoſition on centripetal forces, which he boaſts of having firſt demonſtrated, although it is in every ſtep a tranſcript of the 42d of the 1ſt Book of Newton's Principia, the geometrical language of Newton being changed into algebraic, as he has in the preſent caſe changed Newton's algebraic analyſis into a very elegant geometrical one.

We hope to be forgiven for this long digreſſion. It is a very curious piece of literary hiſtory, and ſhows the combination which envy and want of honourable principle had formed againſt the reputation of our illuſtrious

illuſtrious countryman; and we think it our duty to embrace any opportunity of doing it juſtice.—To return to our ſubject:

13 Accurate meaſure of the accelerative power of gravity.

The accurate meaſure of the accelerative power of gravity, is the *fall* $16\frac{1}{12}$ feet, if we meaſure it by the ſpace, or the *velocity* of $32\frac{1}{6}$ feet per ſecond, if we take the velocity. It will greatly facilitate calculation, and will be ſufficiently exact for all our purpoſes, if we take 16 and 32, ſuppoſing that a body falls 16 feet in a ſecond, and acquires the velocity of 32 feet per ſecond. Then, becauſe the heights are as the ſquares of the times, and as the ſquares of the acquired velocities, a body will fall one foot in one fourth of a ſecond, and will acquire the velocity of eight feet per ſecond. Now let

14 General formulæ deduced.

h expreſs the height in feet, and call it the PRODUCING HEIGHT; v the velocity in feet per ſecond, and call it the PRODUCED VELOCITY, the velocity DUE; and t the time in ſeconds.—We ſhall have the following formulæ, which are of eaſy recollection, and will ſerve, without tables, to anſwer all queſtions relative to projectiles.

$$\text{I.}\quad v = 8\sqrt{h}, = 8\times 4t, = 32t$$

$$\text{II.}\quad t = \frac{\sqrt{h}}{4}, = \frac{v}{32}$$

$$\text{III.}\quad \sqrt{h} = \frac{v}{8}, = 4t$$

$$\text{IV.}\quad h = \frac{v^2}{64}, = 16t^2$$

15 Examples of their uſe in falling bodies,

To give ſome examples of their uſe, let it be required,

1. To find the time of falling through 256 feet. Here $h = 256$, $\sqrt{256} = 16$, and $\frac{16}{4} = 4$. Anſwer 4″.

2. To find the velocity acquired by falling four ſeconds. $t = 4 . 32\times 4 = 128$ feet per ſecond.

3. To find the velocity acquired by falling 625 feet. $h = 625 . \sqrt{h} = 25 . 8\sqrt{h} = 200$ feet per ſecond.

16 In bodies projected upwards,

4. To find the height to which a body will riſe when projected with the velocity of 56 feet per ſecond, or the height through which a body muſt fall to acquire this velocity.

$$v = 56 . \frac{56}{8} = 7, = \sqrt{h} . 7^2 = h, = 49 \text{ feet.}$$

$$\text{or } 56^2 = 3136 . \frac{3136}{64} = 49 \text{ feet.}$$

17 And directly downwards.

5. Suppoſe a body projected directly downwards with the velocity of 10 feet per ſecond; what will be its velocity after four ſeconds? In four ſeconds it will have acquired, by the action of gravity, the velocity of 4×32, or 128 feet, and therefore its whole velocity will be 138 feet per ſecond.

6. To find how far it will have moved, compound its motion of projection, which will be 40 feet in four ſeconds, with the motion which gravity alone would have given it in that time, which is 256 feet; and the whole motion will be 296 feet.

7. Suppoſe the body projected as already mentioned, and that it is required to determine the time it will take to go 296 feet downwards, and the velocity it will have acquired.

Find the height x, through which it muſt fall to acquire the velocity of projection, 10 feet, and the time y of falling from this height. Then find the time z of falling through the height $296+x$, and the velocity v acquired by this fall. The time of deſcribing the 296 feet will be $z-y$, and v is the velocity required.

From ſuch examples, it is eaſy to ſee the way of anſwering every queſtion of the kind.

18 More general formulæ.

Writers on the higher parts of mechanics always compute the actions of other accelerating and retarding forces by comparing them with the acceleration of gravity, and in order to render their expreſſions more general, uſe a ſymbol, ſuch as g for gravity, leaving the reader to convert it into numbers. Agreeably to this view, the general formulæ will ſtand thus:

$$\text{I.}\quad v = \sqrt{2gh},\ i.e.\ \sqrt{2}\sqrt{g}\sqrt{h}, = gt,$$

$$\text{II.}\quad t = \frac{v}{g}, = \frac{\sqrt{4h}}{\sqrt{2g}}, = \sqrt{\frac{4h}{2g}}, = \sqrt{\frac{2h}{g}}$$

$$\text{IIII.}\quad h = \frac{v^2}{2g}, = \frac{gt^2}{2}$$

In all theſe equations, gravity, or its accelerating power, is eſtimated, as it ought to be, by the change of velocity which it generates in a particle of matter in an unit of time. But many mathematicians, in their inveſtigations of curvilineal and other varied motions, meaſure it by the deflection which it produces in this time from the tangent of the curve, or by the increment by which the ſpace deſcribed in an unit of time exceeds the ſpace deſcribed in the preceding unit. This is but one half of the increment which gravity would have produced, had the body moved through the whole moment with the acquired addition of velocity. In this ſenſe of the ſymbol g, the equations ſtand thus:

$$\text{I.}\quad v = 2\sqrt{gh}, = 2gt$$

$$\text{II.}\quad t = \sqrt{\frac{h}{g}}, = \frac{v}{2g}$$

$$\text{IV.}\quad h = \frac{v^2}{4g}, = gt^2, \text{ and } \sqrt{h} = \frac{v}{2\sqrt{g}}$$

It is alſo very uſual to conſider the accelerating force of gravity as the unit of compariſon. This renders the expreſſions much more ſimple. In this way, v expreſſes not the velocity, but the height neceſſary for acquiring it, and the velocity itſelf is expreſſed by $\sqrt{v}$. To reduce ſuch an expreſſion of a velocity to numbers, we muſt multiply it by $\sqrt{2g}$, or by $2\sqrt{g}$, according as we make g to be the generated velocity, or the ſpace fallen through in the unit of time.

19 Bodies projected obliquely.

This will ſuffice for the perpendicular aſcents or deſcents of heavy bodies, and we proceed to conſider their motions when projected obliquely. The circumſtance which renders this an intereſting ſubject, is, that the flight of cannon ſhot and ſhells are inſtances of ſuch motion, and the art of gunnery muſt in a great meaſure depend on this doctrine.

Plate CCCCXVI.

Let a body B (fig. 2.), be projected in any direction BC, not perpendicular to the horizon, and with any velocity. Let AB be the height producing this velocity; that is, let the velocity be that which a heavy body would acquire by falling freely through AB. It is required to determine the path of the body, and all the circumſtances of its motion in this path?

1. It is evident, that by the continual action of gra-

vity, the body will be continually deflected from the line BC, and will describe a curve line BVG, concave towards the earth.

20 [...]cribes [...]rabola. 2. This curve line is a parabola, of which the vertical line ABE is a diameter, B the vertex of this diameter, and BC a tangent in B.

Through any two points V, G of the curve draw VC, GH parallel to AB, meeting BC in C and H, and draw VE, GK parallel to BC, meeting AB in E, K. It follows, from the composition of motions, that the body would arrive at the points V, G of the curve in the same time that it would have uniformly described BC, BH, with the velocity of projection; or that it would have fallen through BE, BK, with a motion uniformly accelerated by gravity; therefore the times of describing BC, BH, uniformly, are the same with the times of falling through BE, BK. But, because the motion along BH is uniform, BC is to BH as the time of describing BC to the time of describing BH, which we may express thus, BC : BH = T, BC : T, BH, = T, BE : T, BK. But, because the motion along BK is uniformly accelerated, we have BE : BK = T^2, BE : T^2, BK, = BC^2 : BH^2, = EV^2 : KG^2; therefore the curve BVG is such, that the abscissæ BE, BK are as the squares of the corresponding ordinates EV, KG; that is, the curve BVG is a parabola, and BC, parallel to the ordinates, is a tangent in the point B.

3. If through the point A there be drawn the horizontal line AD d, it is the directrix of the parabola.

Let BE be taken equal to AB. The time of falling through BE is equal to the time of falling through AB; but BC is described with the velocity acquired by falling through AB: and therefore by n° 4. of perpendicular descents, BC is double of AB, and EV is double of BE; therefore $EV^2 = 4BE^2, = 4BE \times AB, = BE \times 4AB$, and 4AB is the parameter or *latus rectum* of the parabola BVG, and AB being one-fourth of the parameter, AD is the directrix.

4. The times of describing the different arches BV, VG of the parabola are as the portions BC, BH of the tangent, or as the portions AD, A d of the directrix, intercepted by the same vertical lines AB, CV, HG; for the times of describing BV, BVG are the same with those of describing the corresponding parts BC, BH of the tangent, and are proportional to these parts, because the motion along BH is uniform; and BC, BH are proportional to AD, A d.

Therefore the motion estimated horizontally is uniform.

5. The velocity in any point G of the curve is the same with that which a heavy body would acquire by falling from the directrix along dG. Draw the tangent GT, cutting the vertical AB in T; take the points a, f, equidistant from A and d, and extremely near them, and draw the verticals ab, fg; let the points a, f, continually approach A and d, and ultimately coincide with them. It is evident that Bb will ultimately be to gG, in the ratio of the velocity at B to the velocity at G; for the portions of the tangent ultimately coincide with the portions of the curve, and are described in equal times; but Bb is to gG as BH to TG: therefore the velocity at B is to that at G as BH to TG. But, by the properties of the parabola, BH^2 is to TG^2 as AB to dG; and AB is to dG as the square of the velocity acquired by falling through AB to the square of the velocity acquired by falling through dG; and the velocity in BH, or in the point B of the parabola, is the velocity acquired by falling along AB; therefore the velocity in TG, or in the point G of the parabola, is the velocity acquired by falling along dG.

21 The parabolic theory ingenious, but of little use in practice.

These few simple propositions contain all the theory of the motion of projectiles in vacuo, or independent on the resistance of the air; and being a very easy and neat piece of mathematical philosophy, and connected with very interesting practice, and a very respectable profession, they have been much commented on, and have furnished matter for many splendid volumes. But the air's resistance occasions such a prodigious diminution of motion in the great velocities of military projectiles, that this parabolic theory, as it is called, is hardly of any use. A musket-ball, discharged with the ordinary allotment of powder, issues from the piece with the velocity of 1670 feet per second: this velocity would be acquired by falling from the height of eight miles. If the piece be elevated to an angle of 45°, the parabola should be of such extent that it would reach 16 miles on the horizontal plain; whereas it does not reach much above half a mile. Similar deficiencies are observed in the ranges of cannon shot.

22 A short view of it.

We do not propose, therefore, to dwell much on this theory, and shall only give such a synoptical view of it as shall make our readers understand the more general circumstances of the theory, and be masters of the language of the art.

Let OB (fig. 3.) be a vertical line. About the centres A and B, with the distance AB, describe the semicircles ODB, AHK, and with the axis AB, and semiaxis GE, equal to AB, describe the semi-ellipse AEB: with the focus B, vertex A, diameter AB, and tangent AD, parallel to the horizon, describe the parabola APS. Plate CCCCXVII.

Let a body be projected from B, in any direction BC, with the velocity acquired by falling through AB. By what has already been demonstrated, it will describe a parabola BVPM. Then,

1. ADL parallel to the horizon is the directrix of every parabola which can be described by a body projected from B with this velocity. This is evident.

2. The semicircle AHK is the locus of all the foci of these parabolas: For the distance BH of a point B of any parabola from the directrix AD is equal to its distance BF from the focus F of that parabola; therefore the foci of all the parabolas which pass through B, and have AD for their directrix, must be in the circumference of the circle which has AB for its radius, and B for its centre.

3. If the line of direction BC cut the upper semicircle in C, and the vertical line CF be drawn, cutting the lower semicircle in F, F is the focus of the parabola BVPM, described by the body which is projected in the direction BC, with the velocity acquired by falling through BA: for drawing AC, BF, it is evident that ACFB is a rhombus, and that the angle ABF is bisected by BC, and therefore the focus lies in the line BF; but it also lies in the circumference AFK, and therefore in F.

If C is in the upper quadrant of ODB, F is in the upper

upper quadrant of AFK; and if C be in the lower quadrant of ODB (as when BC is the line of direction) then the focus of the correſponding parabola B v M is in the lower quadrant of AHK, as at f.

4. The ellipſis AEB is the locus of the vertex of all the parabolas, and the vertex V of any one of them BVPM is in the interſection of this ellipſis with the vertical CF: for let this vertical cut the horizontal lines AD, GE, BN, in θ, λ, N. Then it is plain that N λ is half of N θ, and λ V is half of C θ; therefore NV is half of NC, and V is the vertex of the axis.

If the focus is in the upper or lower quadrant of the circle AHK, the vertex is in the upper or the lower quadrant of the ellipſe AEG.

5. If BFP be drawn through the focus of any one of the parabolas, ſuch as BVM, cutting the parabola APS in P, the parabola BVM touches the parabola APS in P: for drawing P δ κ parallel to AB, cutting the directrix O κ of the parabola APS in κ, and the directrix AL of the parabola BVM in δ, then PB = Pκ; but BF = BA, = AO, = $\kappa\delta$: therefore Pδ = PF, and the point P is in the parabola BVM. Alſo the tangents to both parabolas in P coincide, for they biſect the angle κ PB; therefore the two parabolas having a common tangent, touch each other in P.

Cor. All the parabolas which can be deſcribed by a body projected from B, with the velocity acquired by falling through AB, will touch the concavity of the parabola APS, and lie wholly within it.

6. P is the moſt diſtant point of the line BP which can be hit by a body projected from B with the velocity acquired by falling through AB. For if the direction is more elevated than BC, the focus of the parabola deſcribed by the body will lie between F and A, and the parabola will touch APS in ſome point between P and A; and being wholly within the parabola APS, it muſt cut the line BP in ſome point within P. The ſame thing may be ſhown when the direction is leſs elevated than BC.

7. The parabola APS is the locus of the greateſt ranges on any planes BP, BS, &c. and no point lying without this parabola can be ſtruck.

8. The greateſt range on any plane BP is produced when the line of direction BC biſects the angle OBP formed by that plane with the vertical: for the parabola deſcribed by the body in this caſe touches APS in P, and its focus is in the line BP, and therefore the tangent BC biſects the angle OBP.

Cor. The greateſt range on a horizontal plane is made with an elevation of 45°.

9. A point M in any plane BS, lying between B and S, may be ſtruck with two directions, BC and Bc; and theſe directions are equidiſtant from the direction Bt, which gives the greateſt range on that plane: for if about the centre M, with the diſtance ML from the directrix AL, we deſcribe a circle LFf, it will cut the circle AHK in two points F and f, which are evidently the foci of two parabolas BVM, B v M, having the directrix AL and diameter ABK. The interſection of the circle ODB, with the verticals FC, fc, determine the directions BC, Bc of the tangents. Draw At parallel to BS, and join tB, Cc, Ff; then OBt = $\frac{1}{2}$ OBS, and Bt is the direction which gives the greateſt range on the plane BS: but becauſe Ff is a chord of the circles deſcribed round the centres B and M, Ff is perpendicular to BM, and Cc to At, and the arches Ct, ct are equal; and therefore the angles CBt, cBt are equal.

Thus we have given a general view of the ſubject, which ſhows the connection and dependence of every circumſtance which can influence the reſult; for it is evident that to every velocity of projection there belongs a ſet of parabolas, with their directions and ranges; and every change of velocity has a line AB correſponding to it, to which all the others are proportional. As the height neceſſary for acquiring any velocity increaſes or diminiſhes in the duplicate proportion of that velocity, it is evident that all the ranges with given elevations will vary in the ſame proportion, a double velocity giving a quadruple range, a triple velocity giving a noncuple range, &c. And, on the other hand, when the ranges are determined beforehand (which is the uſual caſe), the velocities are in the ſubduplicate proportion of the ranges. A quadruple range will require a double velocity, &c.

2 Experi princip directs practic gunner

On the principles now eſtabliſhed is founded the ordinary theory of gunnery, furniſhing rules which are to direct the art of throwing ſhot and ſhells, ſo as to hit the mark with a determined velocity.

But we muſt obſerve, that this theory is of little ſervice for directing us in the practice of cannonading. Here it is neceſſary to come as near as we can to the object aimed at, and the hurry of ſervice allows no time for geometrical methods of pointing the piece after each diſcharge. The gunner either points the cannon directly to the object, when within 200 or 300 yards of it, in which caſe he is ſaid to ſhoot point blank (*pointer au blanc*, i. e. at the white mark in the middle of the gunners target); or, if at a greater diſtance, he eſtimates to the beſt of his judgment the deflection correſponding to his diſtance, and points the cannon accordingly. In this he is aided by the greater thickneſs at the breech of a piece of ordnance. Or, laſtly, when the intention is not to batter, but to rake along a line occupied by the enemy, the cannon is elevated at a conſiderable angle, and the ſhot diſcharged with a ſmall force, ſo that it drops into the enemy's poſt, and bounds along the line. In all theſe ſervices the gunner is directed entirely by trial, and we cannot ſay that this parabolic theory can do him any ſervice.

The principal uſe of it is to direct the bombardier in throwing ſhells. With theſe it is propoſed to break down or ſet fire to buildings, to break through the vaulted roofs of magazines, or to intimidate and kill troops by burſting among them. Theſe objects are always under cover of the enemy's works, and cannot be touched by a direct ſhot. The bombs and carcaſſes are therefore thrown upwards, ſo as to get over the defences and produce their effect.

Theſe ſhells are of very great weight, frequently exceeding 200 lbs. The mortars from which they are diſcharged muſt therefore be very ſtrong, that they may reſiſt the exploſion of gunpowder which is neceſſary for throwing ſuch a maſs of matter to a diſtance; they are conſequently unwieldy, and it is found moſt convenient to make them almoſt a ſolid and immoveable lump. Very little change can be made in their elevation, and therefore their ranges are regulated by the velocities given to the ſhell. Theſe again are produced by the quantities

of powder in the charge; and experience (confirming the beft theoretical notions that we can form of the fubject) has taught us, that the ranges are nearly proportional to the quantities of powder employed, only not increafing quite fo faft. This method is much eafier than by differences of elevation; for we can felect the elevation which gives the greateft range on the given plane, and then we are certain that we are employing the fmalleft quantity of powder with which the fervice can be performed: and we have another advantage, that the deviations which unavoidable caufes produce in the real directions of the bomb will then produce the fmalleft poffible deviation from the intended range. This is the cafe in moft mathematical maxima.

24 mov orce eo:y rent that actice.

In military projectiles the velocity is produced by the explofion of a quantity of gunpowder; but in our theory it is conceived as produced by a fall from a certain height, by the proportions of which we can accurately determine its quantity. Thus a velocity of 1600 feet per fecond is produced by a fall from the height of 40,000 feet or 1333 yards.

ate CXVII.

The height CA (fig. 4.) for producing the velocity of projection is called, in the language of gunnery, the IMPETUS. We fhall exprefs it by the fymbol h.

The diftance AB to which the fhell goes on any plane AB is called the AMPLITUDE or the RANGE r.

The angle DBA, made by the vertical line and the plane AB, may be called the angle of POSITION of that plane, p.

The angle DAB, made by the axis or direction of the piece, and the direction of the object, may be called the angle of ELEVATION of the piece above the plane AB, e.

The angle ZAD, made by the vertical line, and the direction of the piece, may be called the ZENITH diftance, z.

The relations between all the circumftances of velocity, diftance, pofition, elevation, and time, may be included in the following propofitions.

25 Relations between the velocity, diftance, &c.

I. Let a fhell be projected from A, with the velocity acquired by falling through CA, with the intention of hitting the mark B fituated in the given line AB.

Make ZA=4AC, and draw BD perpendicular to the horizon. Defcribe on ZA an arch of a circle ZDA, containing an angle equal to DBA, and draw AD to the interfection of this circle with DB; then will a body projected from A, in the direction AD, with the velocity acquired by falling through CA, hit the mark B.

For, produce CA downwards, and draw BF parallel to AD, and draw ZD. It is evident from the conftruction that AB touches the circle in B, and that the angles ADZ, DBA, are equal, as alfo the angles AZD, DAB; therefore the triangles ZAD, ADB are fimilar.

$$\text{Therefore } BD : DA = DA : AZ,$$
$$\text{And } DA^2 = BD \times AZ;$$
$$\text{Therefore } BF^2 = AF \times AZ, = AF \times 4AC.$$

Therefore a parabola, of which AF is a diameter, and AZ its parameter, will pafs through B, and this parabola will be the path of the fhell projected as already mentioned.

Remark. When BD cuts this circle, it cuts it in two points D, d; and there are two directions which will folve the problem. If B′D′ only touches the circle in D′, there is but one direction, and AB′ is the greateft poffible range with this velocity. If the vertical line through B does not meet the circle, the problem is impoffible, the velocity being too fmall. When B′D′ touches the circle, the two directions AD′ and Ad′ coalefce into one direction, producing the greateft range, and bifecting the angle ZAB; and the other two directions AD, Ad, producing the fame range AB, are equidiftant from AD′, agreeably to the general propofition.

$$\text{It is evident that } AZ : AD = S,ADZ : S,AZD, = S,DBA : S,DAB, = S,p : S,e$$
$$\text{And } AD : DB = S,DBA : S,DAB, = S,p : S,e$$
$$\text{And } DB : AB = S,DAB : S,ADB, = S,e : S,z$$
$$\text{Therefore } AZ : AB = S^2,p \times S,e : S^2,e \times S,z; = S^2,p : S,e \times S,z$$
$$\text{Or } 4h : r = S^2,p : S,e \times S,z, \text{ and } 4h \times S,e \times S,z = r \times S^2,p$$

Hence we obtain the relations wanted.

$$\text{Thus } h = \frac{r \times S^2,p}{4S,e \times S,z}, \text{ and } r = \frac{4h \times S.e \times S,z}{S^2,p}$$

$$\text{And } S,z = \frac{r \times S^2 p}{4h \times S,e}, \text{ and } S,e = \frac{r \times S^2,p}{4h \times S,z}.$$

26 lcu- the of t.

The only other circumftance in which we are interefted is the time of the flight. A knowledge of this is neceffary for the bombardier, that he may cut the fuzes of his fhells to fuch lengths as that they may burft at the very inftant of their hitting the mark.

Now AB : DB = Sin, ADB : Sin, DAB, = S, z : S, e, and $DB = \frac{r \times S,e}{S,z}$. But the time of the flight is the fame with the time of falling through DB, and 16 feet : DB = 1″ : t''^2. Hence $t''^2 = \frac{r \times S,e}{16S,z}$, and we have the following eafy rule.

From the fum of the logarithms of the range, and of the fine of elevation, fubtract the fum of the logarithms of 16, and of the fine of the zenith diftance, half the remainder is the logarithm of the time in feconds.

This becomes ftill eafier in practice; for the mortar fhould be fo elevated that the range is a maximum: in which cafe AB=DB, and then half the difference of the logarithms of AB and of 16 is the logarithm of the time in feconds.

27 The theory of gunnery compared with experiment.

Such are the deductions from the general propofitions which conftitute the ordinary theory of gunnery. It remains to compare them with experiment.

In fuch experiments as can be performed with great accuracy in a chamber, the coincidence is as great as can be wifhed. A jet of water, or mercury, gives us the fineft example, becaufe we have the whole parabola exhibited to us in the fimultaneous places of the fucceeding particles. Yet even in thefe experiments a deviation can be obferved. When the jet is made on a horizontal plane, and the curve carefully traced on a perpendicular plane held clofe by it, it is found that the diftance between the higheft point of the curve and the mark is lefs than the diftance between it and the fpout, and that the defcending branch of the curve is more perpendicular than the afcending branch. And this difference is more remarkable as the jet is made with greater

greater velocity, and reaches to a greater diftance. This is evidently produced by the refiftance of the air, which diminifhes the velocity, without affecting the gravity of the projectile. It is ftill more fenfible in the motion of bombs. Thefe can be traced through the air by the light of their fuzes; and we fee that their higheft point is always much nearer to the mark than to the mortar on a horizontal plane.

The greateft horizontal range on this plane fhould be when the elevation is 45°. It is always found to be much lower.

The ranges on this plane fhould be as the fines of twice the elevation.

A ball difcharged at the elev.	19°. 5′ ranged	448 yards
at	9. 45	330
It fhould have ranged by theory		241

The range at an elevation of 45° fhould be twice the impetus. Mr Robins found that a mufket-ball, difcharged with the ufual allotment of powder, had the velocity of 1700 feet in a fecond. This requires a fall of 45156 feet, and the range fhould be 90312, or $17\frac{1}{8}$ miles; whereas it does not much exceed half a mile. A 24 pound ball difcharged with 16 pounds of powder fhould range about 16 miles; whereas it is generally fhort of 3 miles.

28 This comparifon fhews the deficiency of the theory.

Such facts fhow incontrovertibly how deficient the parabolic theory is, and how unfit for directing the practice of the artillerift. A very fimple confideration is fufficient for rendering this obvious to the moft uninftructed. The refiftance of the air to a very light body may greatly exceed its weight. Any one will feel this in trying to move a fan very rapidly through the air; therefore this refiftance would occafion a greater deviation from uniform motion than gravity would *in that body*. Its path, therefore, through the air may differ more from a parabola than the parabola itfelf deviates from the ftraight line.

It is for fuch cogent reafons that we prefume to fay, that the voluminous treatifes which have been publifhed on this fubject are nothing but ingenious amufements for young mathematicians. Few perfons who have been much engaged in the ftudy of mechanical philofophy have miffed this opportunity in the beginning of their ftudies. The fubject is eafy. Some property of the parabola occurs, by which they can give a neat and fyftematic folution of all the queftions; and at this time of ftudy it feems a confiderable effay of fkill. They are tempted to write a book on the fubject; and it finds readers among other young mechanicians, and employs all the mathematical knowledge that moft of the young gentlemen of the military profeffion are poffeffed of. But thefe performances deferve little attention from the practical artillerift. All that feems poffible to do for his education is, to multiply judicious experiments on real pieces of ordnance, with the charges that are ufed in actual fervice, and to furnifh him with tables calculated from fuch experiments.

Thefe obfervations will ferve to juftify us for having given fo concife an account of this doctrine of the parabolic flight of bodies.

29 Caufes of this deficiency.

But it is the bufinefs of a philofopher to inquire into the caufes of fuch a prodigious deviation from a well founded theory, and having difcovered them, to afcertain precifely the deviations they occafion. Thus we fhall obtain another theory, either in the form of the parabolic theory corrected, or as a fubject of independent difcuffion. This we fhall now attempt.

30 Effect of the atmofphere.

The motion of projectiles is performed in the atmofphere. The air is difplaced, or put in motion. Whatever motion it acquires muft be taken from the bullet. The motion communicated to the air muft be in the proportion of the quantity of air put in motion, and of the velocity communicated to it. If, therefore, the difplaced air be always *fimilarly difplaced*, whatever be the velocity of the bullet, the motion communicated to it, and loft by the bullet, muft be proportional to the fquare of the velocity of the bullet and to the denfity of the air jointly. Therefore the diminution of its motion muft be greater when the motion itfelf is greater, and in the very great velocity of fhot and fhells it muft be prodigious. It appears from Mr Robins's experiments that a globe of $4\frac{1}{2}$ inches in diameter, moving with the velocity of 25 feet in a fecond, fuftained a refiftance of 315 grains, nearly $\frac{3}{4}$ of an ounce. Suppofe this ball to move 800 feet in a fecond, that is 32 times fafter, its refiftance would be 32×32 times $\frac{3}{4}$ of an ounce, or 768 ounces or 48 pounds. This is four times the weight of a ball of caft iron of this diameter; and if the initial velocity had been 1600 feet per fecond, the refiftance would be at leaft 16 times the weight of the ball. It is indeed much greater than this.

31 Compared with that of gravity.

This refiftance, operating conftantly and uniformly on the ball, muft take away four times as much from its velocity as its gravity would do in the fame time. We know that in one fecond gravity would reduce the velocity 800 to 768 if the ball were projected ftraight upwards. This refiftance of the air would therefore reduce it in one fecond to 672, if it operated uniformly; but as the velocity diminifhes continually by the refiftance, and the refiftance diminifhes along with the velocity, the real diminution will be fomewhat lefs than 128 feet. We fhall, however, fee afterwards that in one fecond its velocity will be reduced from 800 to 687. From this fimple inftance we fee that the refiftance of the air muft occafion great deviation from parabolic motion.

32 And confidered as a retarding force.

In order to judge accurately of its effect, we muft confider it as a retarding force, in the fame way as we confider gravity. The weight W of a body is the aggregate of the action of the force of gravity g on each particle of the body. Suppofe the number of equal particles, or the quantity of matter, of a body to be M, then W is equivalent to gM. In like manner, the refiftance R, which we obferve in any experiment, is the aggregate of the action of a retarding force R′ on each particle, and is equivalent to R′M: and as g is equal to $\frac{W}{M}$, fo R′ is equal to $\frac{R}{M}$. We fhall keep this diftinction in view, by adding the differential mark ′ to the letter R or r, which expreffes the aggregate refiftance.

33 The refiftance of air not uniform.

If we, in this manner, confider refiftance as a retarding force, we can compare it with any other fuch force by means of the retardation which it produces in fimilar circumftances. We would compare it with gravity by comparing the diminution of velocity which its uniform action produces in a given time with the diminution produced in the fame time by gravity. But we have no opportunity of doing this directly; for when the refiftance of the air diminifhes the velocity of a body, it diminifhes it gradually, which occafions a gradual diminution of its

own

own intensity. This is not the case with gravity, which has the same action on a body in motion or at rest. We cannot, therefore, observe the uniform action of the air's resistance as a retarding force. We must fall on some other way of making the comparison. We can state them both as dead pressures. A ball may be fitted to the rod of a spring stillyard, and exposed to the impulse of the wind. This will compress the stillyard to the mark 3, for instance. Perhaps the weight of the ball will compress it to the mark 6. We know that half this weight would compress it to 3. We account this equal to the pressure of the air, because they balance the same elasticity of the spring. And in this way we can estimate the resistance by weights, whose pressures are equal to its pressure, and we can thus compare it with other resistances, weights, or any other pressures. In fact, we are measuring them all by the elasticity of the spring. This elasticity in its different positions is supposed to have the proportions of the weights which keep it in these positions. Thus we reason from the nature of gravity, no longer considered as a dead pressure, but as a retarding force; and we apply our conclusions to resistances which exhibit the same pressures, but which we cannot make to act uniformly. This sense of the words must be carefully remembered whenever we speak of resistances in pounds and ounces.

34 ...ity ...elist- ...com- ...d when ...are ....

The most direct and convenient way of stating the comparison between the resistance of the air and the accelerating force of gravity, is to take a case in which we know that they are equal. Since the resistance is here assumed as proportional to the square of the velocity, it is evident that the velocity may be so increased that the resistance shall equal or exceed the weight of the body. If a body be already moving downwards with this velocity, it cannot accelerate; because the accelerating force of gravity is balanced by an equal retarding force of resistance. It follows from this remark, that this velocity is the greatest that a body can acquire by the force of gravity only. Nay, we shall afterwards see that it never can completely attain it; because as it approaches to this velocity, the remaining accelerating force decreases faster than the velocity increases. It may therefore be called the limiting or TERMINAL velocity by gravity.

Let a be the height through which a heavy body must fall, in vacuo, to acquire its terminal velocity in air. If projected directly upwards with this velocity, it will rise again to this height, and the height is half the space which it would describe uniformly, with this velocity, in the time of its ascent. Therefore the resistance to this velocity being equal to the weight of the body, it would extinguish this velocity, by its *uniform* action, in the same time, and after the same distance, that gravity would.

Now let g be the velocity which gravity generates or extinguishes during an unit of time, and let u be the terminal velocity of any particular body. The theorems for perpendicular ascents give us $g = \frac{u^2}{2a}$, u and a being both numbers representing units of space; therefore, in the present case, we have $r' = \frac{u^2}{2a}$. For the whole resistance r, or $r'M$, is supposed equal to the weight, or to gM; and therefore r' is equal to g, $= \frac{u^2}{2a}$ and $2a = \frac{u^2}{g}$. There is a consideration which ought to have place here. A body descends in air, not by the whole of its weight, but by the excess of its weight above that of the air which it displaces. It descends by its *specific* gravity only as a stone does in water. Suppose a body 32 times heavier than air, it will be buoyed up by a force equal to $\frac{1}{32}$ of its weight; and instead of acquiring the velocity of 32 feet in a second, it will only acquire a velocity of 31, even though it sustained no resistance from the *inertia* of the air. Let p be the weight of the body and π that of an equal bulk of air: the accelerative force of relative gravity on each particle will be $g \times 1 - \frac{\pi}{p}$; and this relative accelerating force might be distinguished by another symbol γ. But in all cases in which we have any interest, and particularly in military projectiles, $\frac{\pi}{p}$ is so small a quantity that it would be pedantic affectation to attend to it. It is much more than compensated when we make $g = 32$ feet instead of $32\frac{1}{12}$ which it should be.

Let e be the time of this ascent in opposition to gravity. The same theorems give us $e\,u = 2\,a$; and since the resistance competent to this terminal velocity is equal to gravity, e will also be the time in which it would be extinguished by the uniform action of the resistance; for which reason we may call it the extinguishing time for this velocity. Let R and E mark the resistance and extinguishing time for the same body moving with the velocity 1.

Since the resistances are as the squares of the velocities, and the resistance to the velocity u is $\frac{u^2}{2a}$, R will be $= \frac{1}{2a}$. Moreover, the times in which the same velocity will be extinguished by different forces, acting uniformly, are inversely as the forces, and gravity would extinguish the velocity 1 in the time $\frac{1}{g}$, $=$ (in these measures) to $\frac{1}{\frac{u^2}{2a}}$, $= \frac{2a}{u^2}$. Therefore we have the following proportion $\frac{1}{2a} (= \text{R}) : \frac{u^2}{2a} (= g) = \frac{2a}{u^2} : 2a$, and $2a$ is equal to E, the time in which the velocity 1 will be extinguished by the uniform action of the resistance competent to this veloctiy.

The velocity 1 would in this case be extinguished after a motion uniformly retarded, in which the space described is one-half of what would be uniformly described during the same time with the constant velocity 1. Therefore the space thus described by a motion which begins with the velocity 1, and is uniformly retarded by the resistance competent to this velocity, is equal to the height through which *this* body must fall *in vacuo* in order to acquire *its* terminal velocity in air.

All these circumstances may be conceived in a manner which, to some readers, will be more familiar and palpable. The terminal velocity is that where the resistance of the air balances and is equal to the weight of the body. The resistance of the air to any particular body is as the square of the velocity; therefore let R be the whole resistance to the body moving with the velocity

1, and

1, and r the refiftance to its motion with the terminal velocity u; we muft have $r = R \times u^2$, and this muft be $= W$ the weight. Therefore, to obtain the terminal velocity, divide the weight by the refiftance to the velocity 1, and the quotient is the fquare of the terminal velocity, or $\frac{W}{R} = u^2$: And this is a very expeditious method of determining it, if R be previoufly known.

Then the common theorems give a, the fall neceffary for producing this velocity *in vacuo* $= \frac{u^2}{2g}$, and the time of the fall $= \frac{u}{g} = e$, and $eu = 2a$, = the fpace uniformly defcribed with the velocity u during the time of the fall, or its equal, the time of the extinction by the uniform action of the refiftance r; and, fince r extinguifhes it in the time e, R, which is u^2 times fmaller, will extinguifh it in the time $u^2 e$, and R will extinguifh the velocity 1, which is u times lefs than u, in the time $u e$, that is, in the time $2a$; and the body, moving uniformly during the time $2a$, $=$ E, with the velocity 1, will defcribe the fpace $2a$; and, if the body begin to move with the velocity 1, and be uniformly oppofed by the refiftance R, it will be brought to reft when it has defcribed the fpace a; and the fpace in which the refiftance to the velocity 1 will extinguifh that velocity by its uniform action, is equal to the height through which that body muft fall *in vacuo* in order to acquire its terminal velocity in air. And thus every thing is regulated by the time E in which the velocity 1 is extinguifhed by the uniform action of the correfponding refiftance, or by $2a$, which is the fpace uniformly defcribed during this time, with the velocity 1. And E and $2a$ muft be expreffed by the fame number. It is a number of units, of time, or of length.

35
The comparifon made general.

Having afcertained thefe leading circumftances for an unit of velocity, weight, and bulk, we proceed to deduce the fimilar circumftances for any other magnitude; and, to avoid unneceffary complications, we fhall always fuppofe the bodies to be fpheres, differing only in diameter and denfity.

Firft, then, let the velocity be increafed in the ratio of 1 to v.

The refiftance will now be $\frac{v^2}{2a}$, $= r$.

The extinguifhing time will be $\frac{E}{v}$, $= e$, $= \frac{2a}{v}$, and $e v = 2a$; fo that the rule is general, that the fpace along which *any* velocity will be extinguifhed by the uniform action of the correfponding refiftance, is equal to the height neceffary for communicating the terminal velocity to *that* body by gravity. For $e v$ is twice the fpace through which the body moves while the velocity v is extinguifhed by the uniform refiftance.

In the 2d place, let the diameter increafe in the proportion of 1 to d. The aggregate of the refiftance changes in the proportion of the furface fimilarly refifted, that is, in the proportion of 1 to d^2. But the quantity of matter, or number of particles among which this refiftance is to be diftributed, changes in the proportion of 1 to d^3. Therefore the retarding power of the refiftance changes in the proportion of 1 to $\frac{1}{d}$. When the diameter was 1, the refiftance to a velocity 1 was $\frac{1}{2a}$. It muft now be $\frac{1}{2ad}$. The time in which this diminifhed refiftance will extinguifh the velocity 1 muft increafe in the proportion of the diminution of force, and muft now be E d, or $2ad$, and the fpace uniformly defcribed during this time with the initial velocity 1 muft be $2ad$; and this muft ftill be twice the height neceffary for communicating the terminal velocity w to *this* body. We muft ftill have $g = \frac{w^2}{2ad}$; and therefore $w^2 = 2gad$, and $w = \sqrt{2gad}$, $= \sqrt{2ga}\sqrt{d}$. But $u = \sqrt{2ga}$. Therefore the terminal velocity w for this body is $= u\sqrt{d}$; and the height neceffary for communicating it is ad. Therefore the terminal velocity varies in the fubduplicate ratio of the diameter of the ball, and the fall neceffary for producing it varies in the fimple ratio of the diameter. The extinguifhing time for the velocity v muft now be $\frac{Ed}{v}$.

If, in the 3d place, the denfity of the ball be increafed in the proportion of 1 to m, the number of particles among which the refiftance is to be diftributed is increafed in the fame proportion, and therefore the retarding force of the refiftance is equally diminifhed; and if the denfity of the air is increafed in the proportion of 1 to n, the retarding force of the refiftance increafes in the fame proportion: hence we eafily deduce thefe *general* expreffions.

The terminal velocity $= u\sqrt{d\frac{m}{n}}, = \sqrt{2gad\frac{m}{n}}$

The producing fall *in vacuo* $= ad\frac{m}{n}$

The retarding power of refiftance to any velocity $= r'$, $= \frac{v^2}{2ad\frac{m}{n}}$.

The extinguifhing time for any velocity $v = \frac{Edm}{vn}$.

And thus we fee that the chief circumftances are regulated by the terminal velocity, or are conveniently referred to it.

To render the deductions from thefe premifes perfpicuous, and for communicating diftinct notions or ideas, it will be proper to affume fome convenient units, by which all thefe quantities may be meafured; and, as this fubject is chiefly interefting in the cafe of military projectiles, we fhall adapt our units to this purpofe. Therefore, let a fecond be the unit of time, a foot the unit of fpace and velocity, an inch the unit of diameter of a ball or fhell, and a pound avoirdupoife the unit of preffure, whether of weight or of refiftance; therefore g is 32 feet.

3[6]
Uni[ts] fary [...] which quant[ities] may b[e] meafu[red].

The great difficulty is to procure an abfolute meafure of r, or u, or a; any one of thefe will determine the others.

3[7]
Sir I[saac] Newt[on] endea[vours] in thi[s].

Sir Ifaac Newton has attempted to determine r by theory, and employs a great part of the fecond book of the *Principia* in demonftrating, that the refiftance to a fphere moving with any velocity is to the force which would generate or deftroy its whole motion in the time that it would uniformly move over $\frac{8}{3}$ of its diameter with this velocity as the denfity of the air is to the denfity of the fphere. This is equivalent to demonftrating that the refiftance of the air to a fphere moving through it with any velocity, is equal to half the weight of a column

column of air having a great circle of the fphere for its bafe, and for its altitude the height from which a body muft fall *in vacuo* to acquire this velocity. This appears from Newton's demonftration; for, let the fpecific gravity of the air be to that of the ball as 1 to m; then, becaufe the times in which the fame velocity will be extinguifhed by the uniform action of different forces are inverfely as the forces, the refiftance to this velocity would extinguifh it in the time of defcribing $\frac{8}{3}\,m\,d$, d being the diameter of the ball. Now 1 is to m as the weight of the difplaced air to the weight of the ball, or as $\frac{2}{3}$ of the diameter of the ball to the length of a column of air of equal weight. Call this length a; a is therefore equal to $\frac{2}{3}\,m\,d$. Suppofe the ball to fall from the height a in the time t, and acquire the velocity v. If it moved uniformly with this velocity during this time, it would defcribe a fpace $= 2\,a$, or $\frac{4}{3}\,m\,d$. Now its weight would extinguifh this velocity, or deftroy this motion, in the fame time, that is, in the time of defcribing $\frac{4}{3}\,m\,d$; but the refiftance of the air would do this in the time of defcribing $\frac{8}{3}\,m\,d$; that is, in twice the time. The refiftance therefore is equal to half the weight of the ball, or to half the weight of the column of air whofe height is the height producing the velocity. But the refiftances to different velocities are as the fquares of the velocities; and therefore, as their producing heights, and, in general, the refiftance of the air to a fphere moving with any velocity, is equal to the half weight of a column of air of equal fection, and whofe altitude is the height producing the velocity.

38 efult but eafon- ironc- The refult of this inveftigation has been acquiefced in by all Sir Ifaac Newton's commentators. Many faults have indeed been found with his reafoning, and even with his principles; and it muft be acknowledged that although this inveftigation is by far the moft ingenious of any in the *Principia*, and fets his acutenefs and addrefs in the moft confpicuous light, his reafoning is liable to ferious objections, which his moft ingenious commentators have not completely removed. However, the conclufion has been acquiefced in, as we have already ftated, but as if derived from other principles, or by more logical reafoning. We cannot, however, fay that the reafonings or affumptions of thefe mathematicians are much better than Newton's: and we muft add, that all the caufes of deviation from the duplicate ratio of the velocities, and the caufes of increafed refiftance, which the later authors have valued themfelves for difcovering and introducing into their inveftigations, were pointed out by Sir Ifaac Newton, but purpofely omitted by him, in order to facilitate the difcuffion *in re difficillima*. (See *Schol.* prop. 37. b. ii.)

It is known that the weight of a cubic foot of water is $62\frac{1}{2}$ pounds, and that the medium denfity of the air is $\frac{1}{840}$ of water; therefore let a be the height producing the velocity (in feet), and d the diameter of the ball (in inches), and π the periphery of a circle whofe diameter is 1; the refiftance of the air will be $= \frac{62\frac{1}{2}}{840} \times \frac{\pi}{4} \times \frac{1}{144} \times \frac{a}{2} \times d^2 = \frac{a\,d^2}{4928\frac{1}{2}}$ pounds, very nearly, $= \frac{v^2}{4928\frac{1}{2} \times 64} d^2, = \frac{v^2\,d^2}{315417}$ pounds.

We may take an example. A ball of caft iron weighing 12 pounds, is $4\frac{1}{2}$ inches in diameter. Suppofe this ball to move at the rate of $25\frac{1}{15}$ feet in a fecond (the reafon of this choice will appear afterwards). The height which will produce this velocity in a falling body is $9\frac{7}{8}$ feet. The area of its great circle is 0,11044 feet, or $\frac{11044}{100000}$ of one foot. Suppofe water to be 840 times heavier than air, the weight of the air incumbent on this great circle, and $9\frac{7}{8}$ feet high, is 0,081151 pounds: half of this is 0,0405755 or $\frac{405755}{10000000}$, or nearly $\frac{1}{25}$ of a pound. This fhould be the refiftance of the air to this motion of the ball.

In all matters of phyfical difcuffion, it is prudent to confront every theoretical conclufion with experiment. This is particularly neceffary in the prefent inftance, becaufe the theory on which this propofition is founded is extremely uncertain. Newton fpeaks of it with the moft cautious diffidence, and fecures the juftnefs of the conclufions by the conditions which he affumes in his inveftigation. He defcribes with the greateft precifion the ftate of the fluid in which the body muft move, fo as that the demonftrations may be ftrict, and leaves it to others to pronounce whether this is the real conftitution of our atmofphere. It muft be granted that it is not; and that many other fuppofitions have been introduced by his commentators and followers, in order to fuit his inveftigation (for we muft affert that little or nothing has been added to it) to the circumftances of the cafe. 39 Neceffity of experiment.

Newton himfelf, therefore, attempted to compare his propofitions with experiment. Some were made by dropping balls from the dome of St Paul's cathedral; and all thefe fhowed as great a coincidence with his theory as they did with each other: but the irregularities were too great to allow him to fay with precifion what was the refiftance. It appeared to follow the proportion of the fquares of the velocities with fufficient exactnefs; and though he could not fay that the refiftance was equal to the weight of the column of air having the height neceffary for communicating the velocity, it was always equal to a determinate part of it; and might be ftated $= n\,a$, n being a number to be fixed by numerous experiments. 40 Newton's experiments.

One great fource of uncertainty in his experiments feems to have efcaped his obfervation: the air in that dome is almoft always in a ftate of motion. In the fummer feafon there is a very fenfible current of air downwards, and frequently in winter it is upwards: and this current bears a very great proportion to the velocity of the defcents. Sir Ifaac takes no notice of this.

He made another fet of experiments with pendulums; and has pointed out fome very curious and unexpected circumftances of their motions in a refifting medium. There is hardly any part of his noble work in which his addrefs, his patience, and his aftonifhing penetration, appear in greater luftre. It requires the utmoft intenfenefs of thought to follow him in thefe difquifitions; and we cannot enter on the fubject at prefent: fome notice will be taken of thefe experiments in the article RESISTANCE *of Fluids*. Their refults were much more uniform, and confirmed his general theory; and, as we have faid above, it has been acquiefced in by the firft mathematicians of Europe.

But the deductions from this theory were fo inconfiftent with the obferved motions of military projectiles, when the velocities are prodigious, that no application could be made which could be of any fervice for determining 41 Inutility of the theory in practice.

42 The attempts of various mathematicians, &c. mining the path and motion of cannon ſhot and bombs; and although Mr John Bernoulli gave in 1718 a moſt elegant determination of the trajectory and motion of a body projected in a fluid which reſiſts in the duplicate ratio of the velocities (a problem which even Newton did not attempt), it has remained a dead letter. Mr Benjamin Robins, equally eminent for phyſical ſcience and mathematical genius, was the firſt who ſuſpected the true cauſe of the imperfection of the uſually received theories; and in 1737 he publiſhed a ſmall tract, in which he ſhowed clearly, that even the Newtonian theory of reſiſtance muſt cauſe a cannon ball, diſcharged with a full allotment of powder, to deviate farther from the parabola, in which it would move *in vacuo*, than the parabola deviates from a ſtraight line. But he farther aſſerted, on the authority of good reaſoning, that in ſuch great velocities the reſiſtance muſt be much greater than this theory aſſigns; becauſe, beſides the reſiſtance ariſing from the *inertia* of the air which is put in motion by the ball, there muſt be a reſiſtance airſing from a condenſation of the air on the anterior ſurface of the ball, and a rarefaction behind it: and there muſt be a third reſiſtance, ariſing from the ſtatical preſſure of the air on its anterior part, when the motion is ſo ſwift that there is a vacuum behind. Even theſe cauſes of diſagreement with the theory had been foreſeen and mentioned by Newton (ſee the Scholium to prop. 37, Book II. *Princip.*); but the ſubject ſeems to have been little attended to. The eminent mathematicians had few opportunities of making experiments; and the profeſſional men, who were in the ſervice of princes, and had their countenance and aid in this matter, were generally too deficient in mathematical knowledge to make a proper uſe of their opportunities. The numerous and ſplendid volumes which theſe gentlemen have been enabled to publiſh by the patronage of ſovereigns are little more than prolix extenſions of the ſimple theory of Galileo. Some of them, however, ſuch as St Remy, Antonini, and Le Blond, have given moſt valuable collections of experiments, ready for the uſe of the profound mathematician.

43 Obſervations of Mr Robins on velocity and reſiſtance, Two or three years after this firſt publication, Mr Robins hit upon that ingenious method of meaſuring the great velocities of military projectiles, which has handed down his name to poſterity with great honour. And having aſcertained theſe velocities, he diſcovered the prodigious reſiſtance of the air, by obſerving the diminution of velocity which it occaſioned. This made him anxious to examine what was the real reſiſtance to any velocity whatever, in order to aſcertain what was the law of its variation; and he was equally fortunate in this attempt. His method of meaſuring the reſiſtance has been fully deſcribed in the article GUNNERY, n° 9, &c.

It appears (Robins's *Math. Works*, vol. i. page 205.) that a ſphere of $4\frac{1}{2}$ inches in diameter, moving at the rate of $25\frac{1}{5}$ feet in a ſecond, ſuſtained a reſiſtance of 0,04914 pounds, or $\frac{4914}{100000}$ of a pound. This is a greater reſiſtance than that of the Newtonian theory, which gave $\frac{405755}{10000000}$ in the propoıtion of 1000 to 1211, or very nearly in the proportion of five to ſix in ſmall numbers. And we may adopt as a rule in all moderate velocities, that the reſiſtance to a ſphere is equal to $\frac{61}{100}$ of the weight of a column of air having the great circle of the ſphere for its baſe, and for its altitude the height through which a heavy body muſt fall *in vacuo* to acquire the velocity of projection.

This experiment is peculiarly valuable, becauſe the ball is preciſely the ſize of a 12 pound ſhot of caſt iron; and its accuracy may be depended on. There is but one ſource of error. The whirling motion muſt have occaſioned ſome whirl in the air, which would continue till the ball again paſſed through the ſame point of its revolution. The reſiſtance obſerved is therefore probably ſomewhat leſs than the true reſiſtance to the velocity of $25\frac{1}{5}$ feet, becauſe it was exerted in a relative velocity which was leſs than this, and is, in fact, the reſiſtance competent to this relative and ſmaller velocity. —Accordingly, Mr Smeaton, a moſt ſagacious natu- 44 And of Mr Rouſe and De Borda.
raliſt, places great confidence in the obſervations of Mr Rouſe of Leiceſterſhire, who meaſured the reſiſtance by the effect of the wind on a plane properly expoſed to it. He does not tell us in what way the velocity of the wind was aſcertained; but our deference for his great penetration and experience diſpoſes us to believe that this point was well determined. The reſiſtance obſerved by Mr Rouſe exceeds that reſulting from Mr Robins's experiments nearly in the proportion of 7 to 10. 45 They differ widely in their concluſions.
Chevalier de Borda made experiments ſimilar to thoſe of Mr Robins, and his reſults exceed thoſe of Robins in the proportion of 5 to 6. Theſe differences are ſo conſiderable, that we are at a loſs what meaſure to abide by. It is much to be regretted, that in a ſubject ſo intereſting both to the philoſopher and the man of the world, experiments have not been multiplied. Nothing would tend ſo much to perfect the ſcience of gunnery; and indeed till this be done, all the labours of mathematicians are of no avail. Their inveſtigations muſt remain an unintelligible cipher, till this key be ſupplied. It is to be hoped that Dr Charles Hutton of Woolwich, who has ſo ably extended Mr Robins's Examination of the Initial Velocities of Military Projectiles, will be encouraged to proceed to this part of the ſubject. We ſhould wiſh to ſee, in the firſt place, a numerous ſet of experiments for aſcertaining the reſiſtances in moderate velocities; and, in order to avoid all error from the reſiſtance and inertia of the machine, which is neceſſarily blended with the reſiſtance of the ball, in Mr Robins's form of the experiment, and is ſeparated with great uncertainty and riſk of error, we would recommend a form of experiment ſomewhat different.

Let the axis and arm which carries the ball be connected with wheelwork, by which it can be put in motion, and gradually accelerated. Let the ball be ſo connected with a bent ſpring, that this ſhall gradually compreſs it as the reſiſtance increaſes, and leave a mark of the degree of compreſſion; and let all this part of the apparatus be ſcreened from the air except the ball. The velocity will be determined preciſely by the revolutions of the arm, and the reſiſtance by the compreſſion of the ſpring. The beſt method would be to let this part of the apparatus be made to ſlide along the revolving arm, ſo that the ball can be made to deſcribe larger and larger circles. An intelligent mechanician will eaſily contrive an apparatus of this kind, held at any diſtance from the axis by a cord, which paſſes over a pulley in the axis itſelf, and is then brought along a perforation in the axis, and comes out at its extremity, where it is fitted with a ſwivel, to prevent it from ſnapping by being twiſted. Now let the machine be put in motion. The centrifugal force of the ball and apparatus will cauſe it to fly out as far as it is allowed by the cord; and 46 A new form of experiment recommended.

and if the whole is put in motion by connecting it with fome mill, the velocity may be moft accurately afcertained. It may alfo be fitted with a bell and hammer like Gravefande's machine for meafuring centrifugal forces. Now by gradually veering off more cord, the diftance from the centre, and confequently the velocity and refiftance increafe, till the hammer is difengaged and ftrikes the bell.

Another great advantage of this form of the experiment is, that the refiftance to very great velocities may be thus examined, which was impoffible in Mr Robins's way. This is the great defideratum, that we may learn in what proportion of the velocities the refiftances increafe.

In the fame manner, an apparatus, confifting of Dr Lynd's Anemometer, defcribed in the article PNEUMATICS, n° 311, &c. might be whirled round with prodigious rapidity, and the fluid on it might be made clammy, which would leave a mark at its greateft elevation, and thus difcover the refiftance of the air to rapid motions.

Nay, we are of opinion that the refiftance to very rapid motions may be meafured directly in the conduit pipe of fome of the great cylinder bellows employed in blaft furnaces: the velocity of the air in this pipe is afcertained by the capacity of the cylinder and the ftrokes of the pifton. We think it our duty to point out to fuch as have the opportunities of trying them methods which promife accurate refults for afcertaining this moft defirable point.

47 ...he refult ...Robins's ...periments as ...t moft ...be de...nded on.

We are the more puzzled what meafure to abide by; becaufe Mr Robins himfelf, in his Practical Propofitions, does not make ufe of the refult of his own experiments, but takes a much lower meafure. We muft content ourfelves, however, with this experimental meafure, becaufe it is as yet the only one of which any account can be given, or well-founded opinion formed.

48 ...pplied to ...e formulæ.

Therefore, in order to apply our formulæ, we muft reduce this experiment, which was made on a ball of $4\frac{1}{2}$ inches diameter, moving with the velocity of $25\frac{1}{5}$ feet per fecond, to what would be the refiftance to a ball of one inch, having the velocity 1 foot. This will evidently give us $R = \frac{0{,}04914}{4{,}5^2 \times 25.2^2}$, being diminifhed in the duplicate ratio of the diameter and velocity. This gives us R = 0,00000381973 pounds, or $\frac{3.81973}{1000000}$ of a pound. The logarithm is $\bar{4}{,}58204$. The refiftance here determined is the fame whatever fubftance the ball be of; but the retardation occafioned by it will depend on the proportion of the refiftance to the *vis infita* of the ball; that is, to its quantity of motion. This in fimilar velocities and diameters is as the denfity of the ball. The balls ufed in military fervice are of caft iron or of lead, whofe fpecific gravities are 7,207 and 11,37 nearly, water being 1. There is confiderable variety in caft iron, and this denfity is about the medium. Thefe data will give us

	For Iron.	For Lead.
W, or weight of a ball 1 inch in diameter - -	lbs. 0,13648	0,21533
Log. of W - -	9.13509	9.33310
E″ - - -	1116″,6	1761″,6
Log. of E - -	3.04790	3.24591
u, or terminal velocity	189,03	237,43
Log. *u* - -	2.27653	2.37553
a, or producing height	558,3	880,8

Thefe numbers are of frequent ufe in all queftions on this fubject.

Mr Robins gives an expeditious rule for readily finding *a*, which he calls F (fee the article GUNNERY), by which it is made 900 feet for a caft iron ball of an inch diameter. But no theory of refiftance which he profeffes to ufe will make this height neceffary for producing the terminal velocity. His F therefore is an *empirical* quantity, analogous indeed to the producing height, but accommodated to his theory of the trajectory of cannon-fhot, which he promifed to publifh, but did not live to execute. We need not be very anxious about this; for all our quantities change in the fame proportion with R, and need only a correction by a multiplier or divifor, when R fhall be accurately eftablifhed.

We may illuftrate the ufe of thefe formulæ by an example or two.

1. Then, to find the refiftance to a 24-pound ball moving with the velocity of 1670 feet in a fecond, which is nearly the velocity communicated by 16 lbs. of powder. The diameter is 5,603 inches. 49 Examples of their ufe.

Log. R - -	$+\bar{4}.58204$
Log. d^2 - -	+1.49674
Log. 1670^2 - -	+6.44548
Log. 334,4 lbs. = *r* -	2.52426

But it is found, by unequivocal experiments on the retardation of fuch a motion, that it is 504 lbs. This is owing to the caufes often mentioned, the additional refiftance to great velocities, arifing from the condenfation of the air, and from its preffure into the vacuum left by the ball.

2. Required the terminal velocity of this ball?

Log. R - -	$+\bar{4}.58204$
Log. d^2 - -	+1.49674
Log. refift. to veloc. 1 -	$\bar{6}.07878 = a$
Log. W - -	1.38021 = *b*
Diff. of *a* and *b*, = log u^2 -	5.30143
Log. 447,4 = *u* -	2.65071

As the terminal velocity *u*, and its producing height *a*, enter into all computations of military projectiles, we have inferted the following Table for the ufual fizes of cannon-fhot, computed both by the Newtonian theory of refiftance, and by the refiftances obferved in Robins's experiments. 50 Table of terminal velocity according to Newton and Robins.

Lb. Ball.	Newton.		Robins.		Diam. Inch.
	u Term. Vel.	2 *a*.	Term. Vel.	2 *a*.	
1	289,9	2626,4	263,4	2168,6	1,94
2	324,9	3298,5	295,2	2723,5	2,45
3	348,2	3788,2	316,4	3127,9	2,80
4	365,3	4170,3	331,9	3442,6	3,08
6	390,8	4472,7	355,1	3940,7	3,52
9	418,1	5463,5	379,9	4511,2	4,04
12	438,6	6010,6	398,5	4962,9	4,45
18	469,3	6883,3	426,5	5683,5	5,09
24	492,4	7576,3	447,4	6255,7	5,61
32	512,6	8024,8	465,8	6780,4	6,21
	540,5	9129,9	491,5	7538,3	6,75

Mr Muller, in his writings on this fubject, gives a much

51
Mr Muller's theory altogether erroneous.

much smaller measure of resistance, and consequently a much greater terminal velocity: but his theory is a mistake from beginning to end (See his *Supplement* to his *Treatise of Artillery*, art. 150, &c.) In art. 148. he assumes an algebraic expression for a principle of mechanical argument; and from its consequence draws erroneous conclusions. He makes the resistance of a cylinder $\frac{1}{7}$ less than Newton *supposes* it; and his reason is false. Newton's measure is demonstrated by his commentators Le Seur and Jaquier to be even a little too small, upon his own principles, (Not. 277. Prop. 36. B. II.) Mr Muller then, without any seeming reason, introduces a new principle, which he makes the chief support of his theory, in opposition to the theories of other mathematicians. The principle is false, and even absurd, as we shall have occasion to show by and by. In consequence, however, of this principle, he is enabled to compare the results with many experiments, and the agreement is very flattering. But we shall soon see that little dependence can be had on such comparisons. We notice these things here, because Mr Muller being head of the artillery school in Britain, his publications have become a sort of text-books. We are miserably deficient in works on this subject, and must have recourse to the foreign writers.

52
The motions considered through their whole course.

We now proceed to consider these motions through their whole course: and we shall first consider them as affected by the resistance only; then we shall consider the perpendicular ascents and descents of heavy bodies through the air; and, lastly, their motion in a curvilineal trajectory, when projected obliquely. This must be done by the help of the abstruser parts of fluxionary mathematics. To make it more perspicuous, we shall, by way of introduction, consider the simply resisted rectilineal motions geometrically, in the manner of Sir Isaac Newton. As we advance, we shall quit this track, and prosecute it algebraically, having by this time acquired distinct ideas of the algebraic quantities.

53
Preliminary observations.

We must keep in mind the fundamental theorems of varied motions.

1. The momentary variation of the velocity is proportional to the force and the moment of time jointly, and may therefore be represented by $\pm\dot{v}=f\dot{t}$, where $\dot{v}$ is the momentary increment or decrement of the velocity v, f the accelerating or retarding force, and $\dot{t}$ the moment or increment of the time t.

2. The momentary variation of the square of the velocity is as the force, and as the increment or decrement of the space jointly; and may be represented by $\pm v\dot{v}=f\dot{s}$. The first proposition is familiarly known. The second is the 39th of Newton's *Principia*, B. I. It is demonstrated in the article OPTICS, p. 281. and is the most extensively useful proposition in mechanics.

54
The motions as affected by resistance only.
Plate CCCCXVII.

These things being premised, let the straight line AC (fig. 6.) represent the initial velocity V, and let CO, perpendicular to AC, be the time in which this velocity would be extinguished by the uniform action of the resistance. Draw through the point A an equilateral hyperbola A e B, having OF, OCD for its assymptotes; then let the time of the resisted motion be represented by the line CB, C being the first instant of the motion. If there be drawn perpendicular ordinates $\varkappa e$, gf, DB, &c. to the hyperbola, they will be proportional to the velocities of the body at the instants $\varkappa$, g, D, &c. and the hyperbolic areas AC$\varkappa e$, ACgf, ACDB, &c. will be proportional to the spaces described during the times C$\varkappa$, Cg, CB, &c.

For, suppose the time divided into an indefinite number of small and equal moments, Cc, Dd, &c. draw the ordinates ac, bd, and the perpendiculars $b\beta$, $a\alpha$. Then, by the nature of the hyperbola, AC : ac = Oc : OC; and AC—ac : ac = Oc—OC : OC, that is, Aα : ac = Cc : OC, and Aα : Cc = ac : OC, = AC·ac : AC·OC; in like manner, Bβ : Dd = BD·bD : BD·OD. Now Dd = Cc, because the moments of time were taken equal, and the rectangles AC·CO, BD·DO, are equal, by the nature of the hyperbola; therefore Aα : Bβ = AC·ac : BD·bd: but as the points c, d continually approach, and ultimately coincide with C, D, the ultimate ratio of AC·ac to BD·bd is that of AC^2 to BD^2; therefore the momentary decrements of AC and BD are as AC^2 and BD^2. Now, because the resistance is measured by the momentary diminution of velocity, these diminutions are as the squares of the velocities; therefore the ordinates of the hyperbola and the velocities diminish by the same law; and the initial velocity was represented by AC: therefore the velocities at all the other instants $\varkappa$, g, D, are properly represented by the corresponding ordinates. Hence,

1. Since the abscissæ of the hyperbola are as the times, and the ordinates are as the velocities, the areas will be as the spaces described, and AC$\varkappa e$ is to Acgf as the space described in the time C$\varkappa$ to the space described in the time Cg (1st Theorem on varied motions).

2. The rectangle ACOF is to the area ACDB as the space formerly expressed by $2a$, or E to the space described in the resisting medium during the time CD: for AC being the velocity V, and OC the extinguishing time e, this rectangle is $=e$V, or E, or $2a$, of our former disquisitions; and because all the rectangles, such as ACOF, BDOG, &c. are equal, this corresponds with our former observation, that the space uniformly described with any velocity during the time in which it would be uniformly extinguished by the corresponding resistance is a constant quantity, viz. that in which we always had ev = E, or $2a$.

3. Draw the tangent A$\varkappa$; then, by the hyperbola C$\varkappa$=CO: now C$\varkappa$ is the time in which the resistance to the velocity AC would extinguish it; for the tangent coinciding with the elemental arc Aa of the curve, the first impulse of the uniform action of the resistance is the same with the first impulse of its varied action. By this the velocity AC is reduced to ac. If this operated uniformly like gravity, the velocities would diminish uniformly, and the space described would be represented by the triangle AC$\varkappa$.

This triangle, therefore, represents the height thro' which a heavy body must fall in vacuo, in order to acquire the terminal velocity.

4. The motion of a body resisted in the duplicate ratio of the velocity will continue without end, and a space will be described which is greater than any assignable space, and the velocity will grow less than any that can be assigned; for the hyperbola approaches continually to the assymptote, but never coincides with it. There is no velocity BD so small, but a smaller ZP will be found beyond it; and the hyperbolic space may

may be continued till it exceeds any surface that can be assigned.

5. The initial velocity AC is to the final velocity BD as the sum of the extinguishing time and the time of the retarded motion, is to the extinguishing time alone: for AC : BD = OD (or OC + CD) : OC; or $V : v = e : e + t$.

6. The extinguishing time is to the time of the retarded motion as the final velocity is to the velocity lost during the retarded motion: for the rectangles AFOC, BDOG are equal; and therefore AVGF and BVCD are equal, and VC . VA = VG : VB; therefore $t = e\frac{V-v}{v}$, and $e = t\frac{v}{V-v}$.

7. Any velocity is reduced in the proportion of m to n in the time $e\frac{m-n}{n}$. For, let AC : BD = $m : n$; then DO : CO = $m : n$, and DC : CO = $m - n : n$, and $DC = \frac{m-n}{n}CO$, or $t = e\frac{m-n}{n}$. Therefore any velocity is reduced to one half in the time in which the initial resistance would have extinguished it by its uniform action.

55 Another mode of determining this motion.

Thus may the chief circumstances of this motion be determined by means of the hyperbola, the ordinates and abscissæ exhibiting the relations of the times and velocities, and the areas exhibiting the relations of both to the spaces described. But we may render the conception of these circumstances infinitely more easy and simple, by expressing them all by lines, instead of this combination of lines and surfaces. We shall accomplish this purpose by constructing another curve LKP, having the line MLδ, parallel to OD for its abscissa, and of such a nature, that if the ordinates to the hyperbola AC, $e\kappa$, fg, BD, &c. be produced till they cut this curve in L, p, n, K, &c. and the abscissa in L, s, h, δ, &c. the ordinates sp, hn, δK, &c. may be proportional to the hyperbolic areas eA$c\kappa$, fAcg, δAcK. Let us examine what kind of curve this will be.

Make OC : Oκ = Oκ : Og; then (Hamilton's *Conics*, IV. 14. Cor.), the areas ACκe, $e\kappa gf$ are equal: therefore drawing ps, nt perpendicular to OM, we shall have (by the assumed nature of the curve LpK), Ms = st; and if the abscissa OD be divided into any number of small parts in geometrical progression (reckoning the commencement of them all from O), the axis Vi of this curve will be divided by its ordinates into the same number of equal parts; and this curve will have its ordinates LM, ps, nt, &c. in geometrical progression, and its abscissæ in arithmetical progression.

Also, let KN, MV touch the curve in K and L, and let OC be supposed to be to Oc, as OD to Od, and therefore Cc to Dd as OC to OD; and let these lines Cc, Dd be indefinitely small; then (by the nature of the curve) Lo is equal to Kr: for the areas aACc, bBDd are in this case equal. Also lo is to kr, as LM to KI, because cC : dD = CO : DO:

$$\begin{aligned}\text{Therefore IN} : \text{IK} &= r\text{K} : rk\\ \text{IK} : \text{ML} &= rk : ol\\ \text{ML} : \text{MV} &= ol : o\text{L}\\ \text{and IN} : \text{MN} &= r\text{K} : o\text{L}.\end{aligned}$$

That is, the subtangent IN, or MV, is of the same magnitude, or is a constant quantity in every part of the curve.

Lastly, the subtangent IN, corresponding to the point K of the curve, is to the ordinate Kδ as the rectangle BDOG or ACOF to the parabolic area BDCA.

For let $fghn$ be an ordinate very near to BDδK; and let hn cut the curve in n, and the ordinate KI in q; then we have

$$\begin{aligned}\text{K}q : qn &= \text{KI} : \text{IN, or}\\ \text{D}g : qn &= \text{DO} : \text{IN};\\ \text{but BD} : \text{AC} &= \text{CO} : \text{DO};\\ \text{therefore BD} . \text{D}g : \text{AC} . qn &= \text{CO} : \text{IN}:\end{aligned}$$

Therefore the sum of all the rectangles BD.Dg is to the sum of all the rectangles AC . qn, as CO to IN; but the sum of the rectangles BD . Dg is the space ACDB; and, because AC is given, the sum of the rectangles AC . qn is the rectangle of AC and the sum of all the lines qn; that is, the rectangle of AC and RL: therefore the space ACDB : AC . RL = CO : IN, and ACDB × IN = AC . CO . RL; and therefore IN : RL = AC . CO : ACDB.

Hence it follows that QL expresses the area BVA, and, in general, that the part of the line parallel to OM, which lies between the tangent KN and the curve LpK, expresses the corresponding area of the hyperbola which lies without the rectangle BDOG.

And now, by the help of this curve, we have an easy way of conceiving and computing the motion of a body through the air. For the subtangent of our curve now represents twice the height through which the ball must fall in vacuo, in order to acquire the terminal velocity; and therefore serves for a scale on which to measure all the other representatives of the motion. 56

The whole reduced to a simple arithmetical computation.

But it remains to make another observation on the curve LpK, which will save us all the trouble of graphical operations, and reduce the whole to a very simple arithmetical computation. It is of such a nature, that when MI is considered as the abscissa, and is divided into a number of equal parts, and ordinates are drawn from the points of division, the ordinates are a series of lines in geometrical progression, or are continual proportionals. Whatever is the ratio between the first and second ordinate, there is the same between the second and third, between the third and fourth, and so on; therefore the number of parts into which the abscissa is divided is the number of these equal ratios which is contained in the ratio of the first ordinate to the last: For this reason, this curve has got the name of the *logistic* or *logarithmic* curve; and it is of immense use in the modern mathematics, giving us the solution of many problems in the most simple and expeditious manner, on which the genius of the ancient mathematicians had been exercised in vain. Few of our readers are ignorant, that the numbers called *logarithms* are of equal utility in arithmetical operations, enabling us not only to solve common arithmetical problems with astonishing dispatch, but also to solve others which are quite inaccessible in any other way. Logarithms are nothing more than the numerical measures of the abscissa of this curve, corresponding to ordinates, which are measured on the same or any other scale by the natural numbers; that is, if MLδ be divided into equal parts, and from the points of division lines be drawn parallel to MI,

MI, cutting the curve LpK, and from the points of intersection ordinates be drawn to MI, these will divide MI into portions, which are in the same proportion to the ordinates that the logarithms bear to their natural numbers.

In constructing this curve we were limited to no particular length of the line LR, which represented the space ACDB; and all that we had to take care of was, that when OC, $O\kappa$, Og were taken in geometrical progression, Ms, Mt should be in arithmetical progression. The abscissæ having ordinates equal to ps, nt, &c. might have been twice as long, as is shown in the dotted curve which is drawn through L. All the lines which serve to measure the hyperbolic spaces would then have been doubled. But NI would also have been doubled, and our proportions would have still held good; because this subtangent is the scale of measurement of our figure, as E or $2a$ is the scale of measurement for the motions.

Since then we have tables of logarithms calculated for every number, we may make use of them instead of this geometrical figure, which still requires considerable trouble to suit it to every case. There are two sets of logarithmic tables in common use. One is called a table of hyperbolic or natural logarithms. It is suited to such a curve as is drawn in the figure, where the subtangent is equal to that ordinate $\tau\upsilon$ which corresponds to the side πO of the square $\pi\theta\lambda O$ inserted between the hyperbola and its assymptotes. This square is the unit of surface, by which the hyperbolic areas are expressed; its side is the unit of length, by which the lines belonging to the hyperbola are expressed; $\tau\upsilon$ is $=1$, or the unit of numbers to which the logarithms are suited, and then IN is also 1. Now the square $\theta\pi O\lambda$ being unity, the area BACD will be some number; πO being also unity, OD is some number: Call it x. Then, by the nature of the hyperbola, $OB : O\pi = \pi\theta : DB$: That is, $x : 1 = 1 : \frac{1}{x}$, so that DB is $\frac{1}{x}$. Now calling $Dd\ \dot{x}$, the area $BDdb$, which is the fluxion (ultimately) of the hyperbolic area, is $\frac{\dot{x}}{x}$. Now in the curve LpK, MI has the same ratio to NI that BACD has to $\theta\lambda O\pi$: Therefore, if there be a scale of which NI is the unit, the number on this scale corresponding to MI has the same ratio to 1 which the number measuring BACD has to 1; and Ii, which corresponds to $BDdb$, is the fluxion (ultimately) of MI: Therefore, if MI be called the logarithm of x, $\frac{\dot{x}}{x}$ is properly represented by the fluxion of MI. In short, the line MI is divided precisely as the line of numbers on a Gunter's scale, which is therefore a line of logarithms; and the numbers called logarithms are just the lengths of the different parts of this line measured on a scale of equal parts. Therefore, when we meet with such an expression as $\frac{\dot{x}}{x}$ viz. the fluxion of a quantity divided by the quantity itself, we consider it as the fluxion of the logarithm of that quantity, because it is really so when the quantity is a number; and it is therefore strictly true that the fluent of $\frac{\dot{x}}{x}$ is the hyperbolic logarithm of x.

Certain reasons of convenience have given rise to another set of logarithms; these are suited to a logistic curve whose subtangent is only $\frac{43429}{100000}$ of the ordinate $\tau\upsilon$, which is equal to the side of the hyperbolic square, and which is assumed for the unit of number. We shall suit our applications of the preceding investigation to both these, and shall first use the common logarithms whose subtangent is 0,43429.

57 Illustrated by examples.

The whole subject will be best illustrated by taking an example of the different questions which may be proposed.

Recollect that the rectangle ACOF is $=2a$, or $\frac{u^2}{g}$, or E, for a ball of cast-iron one inch diameter, and if it has the diameter d, it is $\frac{u^2d}{g}$, or $2ad$, or Ed.

I. It may be required to determine what will be the space described in a given time t by a ball setting out with a given velocity V, and what will be its velocity v at the end of that time.

Here we have NI : MI $=$ ACOF : BDCA; now NI is the subtangent of the logistic curve; MI is the difference between the logarithms of OD and OC; that is, the difference between the logarithms of $e+t$ and e; ACOF is $2ad$, or $\frac{u^2d}{g}$, or Ed.

Therefore by common logarithms $0{,}43429 : \text{log.}\ e+t - \text{log.}\ e = 2ad : \text{S}, =$ space described,

or $0{,}43429 : \text{log.}\ \frac{e+t}{e} = 2ad : \text{S}$,

and $\text{S.} = \frac{2ad}{0{,}43429} \times \text{log.}\frac{e+t}{e}$,

by hyperbolic logarithms $\text{S} = 2ad \times \text{log.}\ \frac{e+t}{e}$.

Let the ball be a 12 pounder, and the initial velocity be 1600 feet, and the time 20 seconds. We must first find e, which is $\frac{2ad}{\text{V}}$.

Therefore, log. $2a$	- -	+ 3.03236
log. d (4, 5)	-	+ 0.65321
log. V. (1600)	-	— 3.20412
Log. of $3'',03, = e$	- -	0.48145
And $e+t$ is $23'',03$, of which the log. is		1.36229
from which take the log. of e	-	0.48145
remains the log. of $\frac{e+t}{e}$	- -	0.88084

This must be considered as a common number by which we are to multiply $\frac{2ad}{0{,}43429}$.

Therefore add the logarithms of $2ad$		+ 3.68557
log. $\frac{e+t}{e}$	-	+ 9.94490
log. 0,43429	-	— 9.63778
Log. S. 9833 feet	- -	3.99269

For the final velocity,

OD : OC $=$ AC : BD, or $e+t : e = \text{V} : v$.

$23'',03 : 3'',03 = 1600 : 210\frac{1}{2}, = v$.

The ball has therefore gone 3278 yards, and its velocity is reduced from 1600 to 210.

It

It may be agreeable to the reader to see the gradual progress of the ball during some seconds of its motion.

T.	*S.*	*Diff.*	*V.*	*Diff.*
				397
1″	1383		1203	
		1073		239
2″	2456		964	
		880		160
3″	3336		804	
		744		114
4″	4080		690	
		645		86
5″	4725		604	
		569		67
6″	5294		537	

The first column is the time of the motion, the second is the space described, the third is the differences of the spaces, showing the motion during each successive second; the fourth column is the velocity at the end of the time t; and the last column is the differences of velocity, showing its diminution in each successive second. We see that at the distance of 1000 yards the velocity is reduced to one half, and at the distance of less than a mile it is reduced to one third.

II. It may be required to determine the distance at which the initial velocity V is reduced to any other quantity v. This question is solved in the very same manner, by substituting the logarithms of V and v for those of $e+t$ and e; for AC : BD = OD : OC, and therefore log. $\frac{AC}{BD}$ = log. $\frac{OD}{OC}$, or log. $\frac{V}{v}$ = log. $\frac{e+t}{e}$.

Thus it is required to determine the distance in which the velocity 1780 of a 24 pound ball (which is the medium velocity of such a ball discharged with 16 pounds of powder) will be reduced to 1500.

Here d is 5,68, and therefore the logarithm of $2ad$ is - - +3.78671

Log. $\frac{V}{v}$ = 0,07433, of which the log. is +8.87116

Log. 0,43429 - - −9.63778

Log. 1047,3 feet, or 349 yards 3.02009

This reduction will be produced in about $\frac{7}{8}$ of a second.

III. Another question may be to determine the time which a ball, beginning to move with a certain velocity, employs in passing over a given space, and the diminution of velocity which it sustains from the resistance of the air.

We may proceed thus:

$2ad : S = 0{,}43429 : \log.\frac{e+t}{e}, = t$. Then to log. $\frac{e+t}{e}$ add log. e and we obtain log. $e+t$, and $e+t$; from which if we take e we have t. Then to find v, say $e+t : e = V : v$.

58 [A]pplication [of] an experiment of [M]r Robins. [Se]e *Robins's [M]ath. [W]orks*, vol. [i]. p. 135.

We shall conclude these examples by applying this last rule to Mr Robins's experiment on a musket bullet of $\frac{3}{4}$ of an inch in diameter, which had its velocity reduced from 1670 to 1425 by passing through 100 feet of air. This we do in order to discover the resistance which it sustained, and compare it with the resistance to a velocity of 1 foot *per* second.

We must first ascertain the first term of our analogy. The ball was of lead, and therefore $2a$ must be multiplied by d and by m, which expresses the ratio of the density of lead to that of cast iron. d is 0,75, and m is $\frac{11{,}37}{7{,}21} = 1{,}577$. Therefore log. $2a$ 3.03236

d 9.87506

m 0.19782

Log. $2adm$ 3.10524

and $2adm = 1274{,}2$.

Now $1274{,}2 : 100 = 0{,}43429 : 0{,}03408 = \log.\frac{e+t}{e}$.

But $e = \frac{2adm}{V} = 0{,}763$, and its logarithm = 9.88252, which, added to 0.03408, gives 9.91660, which is the log. of $e+t$, = 0,825, from which take e, and there remains t = 0″,062, or $\frac{62}{1000}$ of a second, for the time of passage. Now, to find the remaining velocity, say 825 : ,763 = 1670 : 1544, = v.

But in Mr Robins's experiment the remaining velocity was only 1425, the ball having lost 245; whereas by this computation it should have lost only 126. It appears, therefore, that the resistance is double of what it would have been if the resistance increased in the duplicate proportion of the velocity. Mr Robins says it is nearly triple. But he supposes the resistance to slow motions much smaller than his own experiment, so often mentioned, fully warrants.

The time e, in which the resistance of the air would extinguish the velocity is 0″,763. Gravity, or the weight of the bullet, would have done it in $\frac{1670}{32}$ or 52″; therefore the resistance is $\frac{52}{0{,}763}$ times, or nearly 68 times its weight, by this theory, or 5,97 pounds. If we calculate from Mr Robins's experiment, we must say log. $\frac{V}{v} : 0{,}43429 = 100 : eV$, which will be 630,23, and $e = \frac{630{,}23}{1670} = 0''{,}3774$, and $\frac{52}{0{,}3774}$ gives 138 for the proportion of the resistance to the weight, and makes the resistance 12,07 pounds, fully double of the other.

It is to be observed, that with this velocity, which greatly exceeds that with which the air can rush into a void, there must be a statical pressure of the atmosphere equal to $6\frac{1}{2}$ pounds. This will make up the difference, and allows us to conclude that the resistance arising solely from the motion communicated to the air follows very nearly the duplicate proportion of the velocity.

The next experiment, with a velocity of 1690 feet, gives a resistance equal to 157 times the weight of the bullet, and this bears a much greater proportion to the former than 1690^2 does to 1670^2; which shows, that although these experiments clearly demonstrate a prodigious augmentation of resistance, yet they are by no means susceptible of the precision which is necessary for discovering the law of this augmentation, or for a good foundation of practical rules; and it is still greatly to be wished that a more accurate mode of investigation could be discovered.

Thus we have explained, in great detail, the principles and the process of calculation for the simple case of 59 Recapitulation.

of the motion of projectiles through the air. The learned reader will think that we have been unreaſonably prolix, and that the whole might have been compriſed in leſs room, by taking the algebraic method. We acknowledge that it might have been done even in a few lines. But we have obſerved, and our obſervation has been confirmed by perſons well verſed in ſuch ſubjects, that in all caſes where the fluxionary proceſs introduces the fluxion of a logarithm, there is a great want of diſtinct ideas to accompany the hand and eye. The ſolution comes out by a ſort of magic or legerdemain, we cannot tell either *how* or *why*. We therefore thought it our duty to furniſh the reader with diſtinct conceptions of the things and quantities treated of. For this reaſon, after ſhowing, in Sir Iſaac Newton's manner, how the ſpaces deſcribed in the retarded motion of a projectile followed the proportion of the hyperbolic areas, we ſhewed the nature of another curve, where lines could be found which increaſe in the very ſame manner as the path of the projectile increaſes; ſo that a point deſcribing the abſciſſa MI of this curve moves preciſely as the projectile does. Then, diſcovering that this line is the ſame with the line of logarithms on a Gunter's ſcale, we ſhewed how the logarithm of a number really repreſents the path or ſpace deſcribed by the projectile. And we were the more diſpoſed to do this, becauſe in the articles LOGARITHMS and *LOGARITHMIC Curve*, there has not been that notice taken of it which would have been proper.

Having thus, we hope, enabled the reader to conceive diſtinctly the quantities employed, we ſhall leave the geometrical method, and proſecute the reſt of the ſubject in a more compendious manner.

60 Of the perpendicular aſcents of heavy projectiles.

We are, in the next place, to conſider the perpendicular aſcents and deſcents of *heavy* projectiles, where the reſiſtance of the air is combined with the action of gravity: and we ſhall begin with the deſcents.

Let u, as before, be the terminal velocity, and g the accelerating power of gravity: When the body moves with the velocity u, the reſiſtance is equal to g; and in every other velocity v, we muſt have $u^2 : v^2 = g : \frac{g v^2}{u^2}, = r$, for the reſiſtance to that velocity. In the deſcent the body is urged by gravity g, and oppoſed by the reſiſtance $\frac{g v^2}{u^2}$: therefore the remaining accelerating force, which we ſhall call f, is $g - \frac{g v^2}{u^2}$, or $\frac{g u^2 - g v^2}{u^2}$, or $\frac{g\,(u^2 - v^2)}{u^2}, = f$.

Now the fundamental theorem for varied motions is $f\dot{s} = u\dot{v}$, and $\dot{s} = \frac{v\dot{v}}{f}, = \frac{u^2}{g} \times \frac{v\dot{v}}{u^2 - v^2}$, and $s = \frac{u^2}{g} \times \int \frac{v\dot{v}}{u^2 - v^2} + C$. Now the fluent of $\frac{v\dot{v}}{u^2 - v^2}$ is $=$ — hyperb. log of $\sqrt{u^2 - v^2}$. For the fluxion of $\sqrt{u^2 - v^2}$ is $\frac{-v\dot{v}}{\sqrt{u^2 - v^2}}$, and this divided by the quantity $\sqrt{u^2 - v^2}$, of which it is the fluxion, gives preciſely $\frac{v\dot{v}}{u^2 - v^2}$, which is therefore the fluxion of its hyperbolic logarithm. Therefore $S = -\frac{u^2}{g} \times L\sqrt{u^2 - v^2} + C$. Where L means the hyperbolic logarithm of the quantity annexed to it, and λ may be uſed to expreſs its common logarithm. (See article FLUXIONS).

The conſtant quantity C for completing the fluent is determined from this conſideration, that the ſpace deſcribed is o, when the velocity is o: therefore $C - \frac{u^2}{g} \times L\sqrt{u^2} = o$, and $C = \frac{u^2}{g} \times L\sqrt{u^2}$, and the complete fluent $S = \frac{u^2}{g} \times \overline{L\sqrt{u^2} - L\sqrt{u^2 - v^2}}$, $= \frac{u^2}{g} \times L\sqrt{\frac{u^2}{u^2 - v^2}}. = \frac{u^2}{0{,}43429\,g} \times \lambda\sqrt{\frac{u^2}{u^2 - v^2}}$, or (putting M for 0,43429, the modulus or ſubtangent of the common logiſtic curve) $= \frac{u^2}{Mg} \times \lambda\sqrt{\frac{u^2}{u^2 - v^2}}$.

This equation eſtabliſhes the relation between the ſpace fallen through, and the velocity acquired by the fall. We obtain by it $\frac{gS}{u^2} = L\sqrt{\frac{u^2}{u^2 - v^2}}$, and $\frac{2gS}{u^2} = L \cdot \frac{u^2}{u^2 - v^2}$, or, which is ſtill more convenient for us, $\frac{M \times 2gS}{u^2} = \lambda\,\frac{u^2}{u^2 - v^2}$, that is, equal to the logarithm of a certain number: therefore having found the natural number correſponding to the fraction $\frac{M \times 2gS}{u^2}$, conſider it as a logarithm, and take out the number correſponding to it: call this n. Then, ſince n is equal to $\frac{u^2}{u^2 - v^2}$, we have $n u^2 - n v^2 = u^2$, and $n u^2 - u^2 = n v^2$, or $n v^2 = u^2 \times \overline{n - 1}$, and $v^2 = \frac{u^2 \times \overline{n - 1}}{n}$.

To expedite all the computations on this ſubject, it will be convenient to have multipliers ready computed for $M \times 2g$, and its half,

viz. 27,794, whoſe log. is	-	1.44396
and 13,897	- - -	1.14293.

But v may be found much more expeditiouſly by obſerving that $\sqrt{\frac{u^2}{u^2 - v^2}}$ is the ſecant of an arch of a circle whoſe radius is u, and whoſe ſine is v, or whoſe radius is unity and ſine $= \frac{v}{u}$: therefore, conſidering the above fraction as a logarithmic ſecant, look for it in the tables, and then take the ſine of the arc of which this is the ſecant, and multiply it by u; the product is the velocity required.

We ſhall take an example of a ball whoſe terminal velocity is $689\frac{1}{3}$ feet, and aſcertain its velocity after a fall of 1848 feet. Here,

$u^2 = 475200$	and its log.	-	$= 5.67688$
$u = 689\frac{1}{3}$	-	-	2.83844
$g = 32$	-	-	1.50515
$S = 1848$	-	-	3.26670

Then

Then log. 27,794	- -	+ 1.44396
log. S	- -	+ 3.26670
log. u^2	- -	— 5.67688

Log. of 0,10809 = log. n - 9.03378

0,10809 is the logarithm of 1,2826 $= n$, and $n - 1 =$ 0,2826, and $\frac{u^2 \times \overline{n-1}}{n} = 323{,}6^2, = v^2$, and $v =$ 323,6.

In like manner, 0,054045 (which is half of 0,10809) will be found to be the logarithmic fecant of 28°, whofe fine 0,46947 multiplied by 689⅓ gives 324 for the velocity.

The procefs of this folution fuggefts a very perfpicuous manner of conceiving the law of defcent; and it may be thus expreffed:

M is to the logarithm of the fecant of an arch whofe fine is $\frac{v}{u}$, and radius 1, as $2a$ is to the height through which the body muft fall in order to acquire the velocity v. Thus, to take the fame example.

1. Let the height b be fought which will produce the velocity 323,62, the terminal velocity of the ball being 689,34. Here $2a$, or $\frac{u^2}{g}$ is 14850, and $\frac{323{,}62}{689{,}34} =$ 0,46947, which is the fine of 28°. The logarithmic fecant of this arch is 0,05407. Now M or 0,43429 : 0,05407 = 14850 : 1848, the height wanted.

2. Required the velocity acquired by the body by falling 1848 feet. Say 14850 : 1848 = 0,43429 : 0,05407. Look for this number among the logarithmic fecants. It will be found at 28°, of which the logarithmic fine is - - - 9.67161

Add to this the log. of u - - 2.83844

The fum - - - - 2.51005

is the logarithm of 323,62, the velocity required.

We may obferve, from thefe folutions, that the acquired velocity continually approaches to, but never equals, the terminal velocity. For it is always expreffed by the fine of an arch of which the terminal velocity is the radius.

61 Erroneous affertion of Mr Muller.

We cannot help taking notice here of a very ftrange affertion of Mr Muller, late profeffor of mathematics and director of the royal academy at Woolwich. He maintains, in his Treatife on Gunnery, his Treatife of Fluxions, and in many of his numerous works, that a body cannot poffibly move through the air with a greater velocity than this; and he makes this a fundamental principle, on which he eftablifhes a theory of motion in a refifting medium, which he afferts with great confidence to be the only juft theory; faying, that all the inveftigations of Bernoulli, Euler, Robins, Simpfon, and others, are erroneous. We ufe this ftrong expreffion, becaufe, in his criticifms on the works of thofe celebrated mathematicians, he lays afide good manners, and taxes them not only with ignorance, but with difhonefty; faying, for inftance, that it required no fmall dexterity in Robins to confirm by his experiments a theory founded on falfe principles; and that Thomas Simpfon, in attempting to conceal his obligations to him for fome valuable propofitions, by changing their form, had ignorantly fallen into grofs errors.

Nothing can be more palpably abfurd than this affertion of Mr Muller. A blown bladder will have but a fmall terminal velocity; and when moving with this velocity, or one very near it, there can be no doubt that it will be made to move much fwifter by a fmart ftroke. Were the affertion true, it would be impoffible for a portion of air to be put into motion through the reft, for its terminal velocity is nothing. Yet this author makes this affertion a principle of argument, faying, that it is impoffible that a ball can iffue from the mouth of a cannon with a greater velocity than this; and that Robins and others are grofsly miftaken, when they give them velocities three or four times greater, and refiftances which are 10 or 20 times greater than is poffible; and by thus compenfating his fmall velocities by ftill fmaller refiftances, he confirms his theory by many experiments adduced in fupport of the others. No reafon whatever can be given for the affertion. Newton, or perhaps Huygens, was the firft who obferved that there was a limit to the velocity which gravity could communicate to a body; and this limit was found by his commentators to be a term to which it was vaftly convenient to refer all its other motions. It therefore became an object of attention; and Mr Muller, through inadvertency, or want of difcernment, has fallen into this miftake, and with that arrogance and felf-conceit which mark all his writings, has made this miftake a fundamental principle, becaufe it led him to eftablifh a novel fet of doctrines on this fubject. He was fretted at the fuperior knowledge and talents of Mr Simpfon, his inferior in the academy, and was guilty of feveral mean attempts to hurt his reputation. But they were unfuccefsful.

62 Motion of a body projected downwards.

We might proceed to confider the motion of a body projected downwards. While the velocity of projection is lefs than the terminal velocity, the motion is determined by what we have already faid: for we muft compute the height neceffary for acquiring this velocity in the air, and fuppofe the motion to have begun there. But if the velocity of projection be greater, this method fails. We pafs it over (though not in the leaft more difficult than what has gone before), becaufe it is of mere curiofity, and never occurs in any interefting cafe. We may juft obferve, that fince the motion is fwifter than the terminal velocity, the refiftance muft be greater than the weight, and the motion will be retarded. The very fame procefs will give us for the fpace defcribed $S = \frac{u^2}{g} \times L \sqrt{\frac{V^2 - u^2}{v^2 - u^2}}$, V being the velocity of projection, greater than u. Now as this fpace evidently increafes continually (becaufe the body always falls), but does not become infinite in any finite time, the fraction $\frac{V^2 - u^2}{v^2 - u^2}$ does not become infinite; that is, v^2 does not become equal to u^2: therefore although the velocity V is continually diminifhed, it never becomes fo fmall as u. Therefore u is a limit of diminution as well as of augmentation.

63 Relation between the time of defcent and fpace defcribed, &c.

We muft now afcertain the relation between the time of the defcent and the fpace defcribed, or the velocity acquired. For this purpofe we may ufe the other fundamental propofition of varied motions $f\dot{t} = \dot{v}$, which, in the prefent cafe, becomes $\frac{g\,\overline{u^2 - v^2}}{u^2}\dot{t} = \dot{v}$; therefore $\dot{t} =$

u^2

$\frac{u^2}{g}\times\frac{\dot v}{u^2-v^2}, =\frac{u}{g}\times\frac{u\dot v}{u^2-v^2}$, and $t=\frac{u}{g}\times\int\frac{u\dot v}{u^2-v^2}$.

Now (art. FLUXIONS) $\int\frac{u\dot v}{u^2-v^2}=\mathrm{L}\sqrt{\frac{u+v}{u-v}}$. Therefore $t=\frac{u}{g}\times\mathrm{L}\sqrt{\frac{u+v}{u-v}},=\frac{u}{\mathrm{M}g}\times\lambda\sqrt{\frac{u+v}{u-v}}$. This fluent needs no constant quantity to complete it, or rather $\mathrm{C}=o$; for t must be $=o$ when $v=o$. This will evidently be the case: for then $\mathrm{L}\sqrt{\frac{u+v}{u-v}}$ is $\mathrm{L}\sqrt{\frac{u}{u}},=\mathrm{L}\,1,=0$.

But how does this quantity $\frac{u}{\mathrm{M}g}\times\lambda\sqrt{\frac{u+v}{u-v}}$ signify a time? Observe, that in whatever numbers, or by whatever units of space and time, u and g are expressed, $\frac{u}{g}$ expresses the number of units of time in which the velocity u is communicated or extinguished by gravity; and $\mathrm{L}\sqrt{\frac{u+v}{u-v}}$, or $\frac{\lambda}{\mathrm{M}}\sqrt{\frac{u+v}{u-v}}$, is always an abstract number, multiplying this time.

We may illustrate this rule by the same example. In what time will the body acquire the velocity 323,62? Here $u+v=1012{,}96$, $u-v=365{,}72$; therefore $\lambda\sqrt{\frac{u+v}{u-v}}=0{,}22122$, and $\frac{u}{g}$ (in feet and seconds) is $21'',542$. Now, for greater perspicuity, convert the equation $t=\frac{u}{\mathrm{M}g}\times\lambda\sqrt{\frac{u+v}{u-v}}$ into a proportion: thus $\mathrm{M}:\lambda\sqrt{\frac{u+v}{u-v}}=\frac{u}{g}:t$, and we have $0{,}43429:0{,}22122=21'',542:10'',973$, the time required.

This is by far the most distinct way of conceiving the subject; and we should always keep in mind that the numbers or symbols which we call logarithms are really parts of the line MI in the figure of the logistic curve, and that the motion of a point in this line is precisely similar to that of the body. The Marquis Poleni, in a dissertation published at Padua in 1725, has with great ingenuity constructed logarithmics suited to all the cases which can occur. Herman, in his *Phoronomia*, has borrowed much of Poleni's methods, but has obscured them by an affectation of language geometrically precise, but involving the very obscure notion of abstract ratios.

It is easy to see that $\sqrt{\frac{u+v}{u-v}}$ is the cotangent of the $\frac{1}{2}$ complement of an arch, whose radius is 1, and

Plate CCCCXVII. whose sine is $\frac{v}{u}$: For let KC (fig. 6.) be $=u$, and BE$=v$; then KD$=u+v$, and DA$=u-v$. Join KB and BA, and draw CG parallel to KB. Now GA is the tangent of $\frac{1}{2}$ BA, $=\frac{1}{2}$ complement of HB. Then, by similarity of triangles, GA : AC = AB : BK, $=\sqrt{\mathrm{AD}}:\sqrt{\mathrm{DK}}=\sqrt{u-v}:\sqrt{u+v}$ and $\frac{\mathrm{AC}}{\mathrm{GA}}$(= cotan. $\frac{1}{2}$BA) $=\sqrt{\frac{u+v}{u-v}}$; therefore look for $\frac{v}{u}$ among the natural sines, or for log. $\frac{v}{u}$ among the logarithmic sines, and take the logarithmic cotangent of the half complement of the corresponding arch. This, considered as a common number, will be the second term of our proportion. This is a shorter process than the former.

By reversing this proportion we get the velocity corresponding to a given time.

64 Fall of a body in air compared with that of one in vacuo.

To compare this descent of 1848 feet in the air with the fall of the body *in vacuo* during the same time, say $21'',542^2:10'',973^2=1848:1926{,}6$, which makes a difference of 79 feet.

Cor. 1. The time in which the body acquires the velocity u by falling through the air, is to the time of acquiring the same velocity by falling *in vacuo*, as $u\cdot\mathrm{L}\sqrt{\frac{u+v}{u-v}}$ to v: for it would acquire this velocity *in vacuo* during the time $\frac{v}{g}$, and it acquires it in the air in the time $\frac{u}{g}\mathrm{L}\sqrt{\frac{u+v}{u-v}}$.

2. The velocity which the body acquires by falling through the air in the time $\frac{u}{g}\mathrm{L}\sqrt{\frac{u+v}{u-v}}$, is to the velocity which it would acquire *in vacuo* during the same time, as v to $u\,\mathrm{L}\sqrt{\frac{u+v}{u-v}}$: For the velocity which it would acquire *in vacuo* during the time $\frac{u}{g}\mathrm{L}\sqrt{\frac{u+v}{u-v}}$ must be $u\,\mathrm{L}\sqrt{\frac{u+v}{u-v}}$ (because in any time $\frac{w}{g}$ the velocity w is acquired).

65 Time of the ascent of a body projected perpendicularly.

In the next place, let a body, whose terminal velocity is u, be projected perpendicularly upwards, with any velocity V. It is required to determine the height to which it ascends, so as to have any remaining velocity v, and the time of its ascent; as also the height and time in which its whole motion will be extinguished.

We have now $\frac{g(u^2+v^2)}{u^2}$ for the expression of f; for both gravity and resistance act now in the same direction, and retard the motion of the ascending body: therefore $\frac{g(u^2+v^2)}{u^2}\dot s=-v\dot v$, and $\dot s=-\frac{u^2}{g}\times\frac{v\dot v}{u^2+v^2}$, and $s=-\frac{u^2}{g}\times\int\frac{v\dot v}{u^2+v^2}+\mathrm{C},=-\frac{u^2}{g}\times\mathrm{L}\sqrt{u^2+v^2}+\mathrm{C}$ (see art. FLUXIONS). This must be $=o$ at the beginning of the motion, that is, when $v=\mathrm{V}$, that is, $-\frac{u^2}{g}\times\mathrm{L}\sqrt{u^2+\mathrm{V}^2}+\mathrm{C}=o$, or $\mathrm{C}=\frac{u^2}{g}\times\mathrm{L}\sqrt{u^2+\mathrm{V}^2}$, and the complete fluent will be $s=\frac{u^2}{g}\times\left(\mathrm{L}\sqrt{u^2+\mathrm{V}^2}-\mathrm{L}\sqrt{u^2+v^2}\right)=\frac{u^2}{g}\times\mathrm{L}\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v^2}},=\frac{u^2}{\mathrm{M}g}\times\lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v^2}}$.

Let b be the greatest height to which the body will rise. Then $s=b$ when $v=o$; and $b=\frac{u^2}{g}\times\mathrm{L}\sqrt{\frac{u^2+\mathrm{V}^2}{u^2}},=\frac{u^2}{\mathrm{M}g}\times\lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2}}$. We have $\lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v^2}}=s\frac{mg}{u^2}$; therefore $\lambda\left(\frac{u^2+\mathrm{V}^2}{u^2+v^2}\right)=\frac{2\mathrm{M}gs}{u^2}$.

Therefore

Therefore let n be the number whose common logarithm is $\frac{2Mgs}{u^2}$; we shall have $n = \frac{u^2+V^2}{u^2+v^2}$, and $v^2 = \frac{u^2+V^2}{n} - u^2$; and thus we obtain the relation of s and v, as in the case of descents: but we obtain it still easier by observing that $\sqrt{u^2+V^2}$ is the secant of an arch whose radius is u, and whose tangent is V, and that $\sqrt{u^2+v^2}$ is the secant of another arch of the same circle, whose tangent is v.

Let the same ball be projected upwards with the velocity 411,05 feet per second. Required the whole height to which it will rise?

Here $\frac{V}{u}$ will be found the tangent of 30.48$\frac{1}{3}$, the logarithmic secant of which is 0,06606. This, multiplied by $\frac{u^2}{Mg}$, gives 2259 feet for the height. It would have risen 2640 feet in a void.

66 city of ection pared h that h which aches ground.

Suppose this body to fall down again. We can compare the velocity of projection with the velocity with which it again reaches the ground. The ascent and descent are equal: therefore $\sqrt{\frac{u^2+V^2}{u^2}}$, which multiplies the constant factor in the ascent, is equal to $\sqrt{\frac{u^2}{u^2-v^2}}$, the multiplier in the descent. The first is the secant of an arch whose tangent is V; the other is the secant of an arch whose sine is v. These secants are equal, or the arches are the same; therefore the velocity of projection is to the final returning velocity as the tangent to the sine, or as the radius to the cosine of the arch. Thus suppose the body projected with the terminal velocity, or $V=u$; then $v=\frac{u}{\sqrt{2}}$. If V = 689, $v=487$.

We must in the last place ascertain the relation of the space and the time.

Here $\frac{g(u^2+v^2)}{u^2}\dot{t} = -\dot{v}$, and $\dot{t} = -\frac{u^2}{g}\times\frac{\dot{v}}{u^2+v^2}, = -\frac{u}{g}\times\frac{u\dot{v}}{u^2+v^2}$; and $t = \frac{-u}{g}\times\int\frac{u\dot{v}}{u^2+v^2}+C$. Now (art. Fluxions) $\int\frac{u\dot{v}}{u^2+v^2}$ is an arch whose tangent $=\frac{v}{u}$ and radius 1; therefore $t = -\frac{u}{g}\times \text{arc. tan.}\frac{v}{u}+C$. This must be $=o$ when $v=V$, or $C-\frac{u}{g}\times \text{arc. tan.}\frac{V}{u}=o$, and $C=\frac{u}{g}\times \text{arc. tan.}\frac{V}{u}$, and the complete fluent is $t=\frac{u}{g}\times\left(\text{arc. tan.}\frac{V}{u} - \text{arc. tan.}\frac{v}{u}\right)$. The quantities within the brackets express a portion of the arch of a circle whose radius is unity; and are therefore abstract numbers, multiplying $\frac{u}{g}$, which we have shown to be the number of units of time in which a heavy body falls *in vacuo* from the height a, or in which it acquires the velocity u.

67 me of ent limited.

We learn from this expression of the time, that however great the velocity of projection, and the height to which this body will rise, may be the time of its ascent is limited. It never can exceed the time of falling from the height a *in vacuo* in a greater proportion than that of a quadrantal arch to the radius, nearly the proportion of 8 to 5. A 24 pound iron ball cannot continue rising above 14 seconds, even if the resistance to quick motions did not increase faster than the square of the velocity. It probably will attain its greatest height in less than 12 seconds, let its velocity be ever so great.

In the preceding example of the whole ascent, $v=o$, and the time $t=\frac{u}{g}\times$ arc. tan. $\frac{V}{u}$, or $\frac{u}{g}$ arc. 30°.48′. Now 30°.48′ = 1848′, and the radius 1 contains 3438; therefore the arch $=\frac{1848}{3438}$, $=0,5376$; and $\frac{u}{g}=21'',54$. Therefore $t=21'',54\times0,5376,=11'',58$, or nearly 11$\frac{1}{2}$ seconds. The body would have risen to the same height in a void in 10$\frac{3}{4}$ seconds.

Cor. 1. The time in which a body, projected in the air with any velocity V, will attain its greatest height, is to that in which it would attain its greatest height *in vacuo*, as the arch whose tangent expresses the velocity is to the tangent; for the time of the ascent in the air is $\frac{u}{g}\times$ arch; the time of the ascent *in vacuo* is $\frac{V}{g}$. Now $\frac{V}{u}$ is = tan. and $V=u\times$ tan. and $\frac{V}{g}=\frac{u}{g}\times$ tan. 68 This time compared in bodies projected in air and in vacuo.

It is evident, by inspecting fig. 6. that the arch AI is to the tangent AG as the sector ICA to the triangle GCA; therefore the time of attaining the greatest height in the air is to that of attaining the greatest height *in vacuo* (the velocities of projection being the same), as the circular sector to the corresponding triangle. Plate cccxvii.

If therefore a body be projected upwards with the terminal velocity, the time of its ascent will be to the time of acquiring this velocity *in vacuo* as the area of a circle to the area of the circumscribed square.

2. The height H to which a body will rise in a void, is to the height h to which it would rise through the air when projected with the same velocity V as $M\cdot V^2$ to $u^2\times\lambda\frac{u^2+V^2}{u^2}$: for the height to which it will rise *in vacuo* is $\frac{V^2}{2g}$, and the height to which it rises in the air is $\frac{u^2}{Mg}\lambda\sqrt{\frac{u^2+V^2}{u^2}}$; therefore $H:h=\frac{V^2}{2g}:\frac{u^2}{Mg}\lambda\sqrt{\frac{u^2+V^2}{u^2}}, = V^2 : \frac{u^2}{M}\times 2\lambda\sqrt{\frac{u^2+V^2}{u^2}}, = V^2 : \frac{u^2}{M}\times\lambda\frac{u^2+V^2}{u^2}, = M\cdot V^2 : u^2\times\lambda\frac{u^2+V^2}{u^2}$.

Therefore if the body be projected with its terminal velocity, so that $V=u$, the height to which it will rise in the air is $\frac{30103}{43429}$ of the height to which it will rise *in vacuo*, or $\frac{5}{7}$ in round numbers.

We have been thus particular in treating of the perpendicular ascents and descents of heavy bodies through the air, in order that the reader may conceive distinctly

the quantities which he is thus combining in his algebraic operations, and may see their connection in nature with each other. We shall also find that, in the present state of our mathematical knowledge, this simple state of the case contains almost all that we can determine with any confidence. On this account it were to be wished that the professional gentlemen would make many experiments on these motions. There is no way that promises so much for assisting us in forming accurate notions of the air's resistance. Mr Robins's method with the pendulum is impracticable with great shot; and the experiments which have been generally resorted to for this purpose, viz. the ranges of shot and shells on a horizontal plane, are so complicated in themselves, that the utmost mathematical skill is necessary for making any inferences from them; and they are subject to such irregularities, that they may be brought to support almost any theory whatever on this subject. But the perpendicular flights are affected by nothing but the initial velocity and the resistance of the air; and a considerable deviation from their intended direction does not cause any sensible error in the consequences which we may draw from them for our purpose.

69 Necessity of further experiments.

70 Of oblique projection.

But we must now proceed to the general problem, to determine the motion of a body projected in any direction, and with any velocity. Our readers will believe beforehand that this must be a difficult subject, when they see the simplest cases of rectilineal motion abundantly abstruse: it is indeed so difficult, that Sir Isaac Newton has not given a solution of it, and has thought himself well employed in making several approximations, in which the fertility of his genius appears in great lustre. In the tenth and subsequent propositions of the second book of the *Principia*, he shows what state of density in the air will comport with the motion of a body in any curve whatever: and then, by applying this discovery to several curves which have some similarity to the path of a projectile, he finds one which is not very different from what we may suppose to obtain in our atmosphere. But even this approximation was involved in such intricate calculations, that it seemed impossible to make any use of it. In the second edition of the *Principia*, published in 1713, Newton corrects some mistakes which he had committed in the first, and carries his approximations much farther, but still does not attempt a direct investigation of the path which a body will describe in our atmosphere. This is somewhat surprising. In prop. 14. &c. he shows how a body, actuated by a centripetal force, in a medium of a density varying according to certain laws, will describe an eccentric spiral, of which he assigns the properties, and the law of description. Had he supposed the density constant, and the difference between the greatest and least distances from the centre of centripetal force exceedingly small in comparison with the distances themselves, his spiral would have coincided with the path of a projectile in the air of uniform density, and the steps of his investigation would have led him immediately to the complete solution of the problem. For this is the real state of the case. A heavy body is not acted on by equal and parallel gravity, but by a gravity inversely proportional to the square of the distance from the centre of the earth, and in lines tending to that centre nearly; and it was with the view of simplifying the investigation, that mathematicians have adopted the other hypothesis.

71 This problem not solved by Newton.

72 Dispute among British and foreign mathematicians.

Soon after the publication of this second edition of the *Principia*, the dispute about the invention of the fluxionary calculus became very violent, and the great promoters of that calculus upon the continent were in the habit of proposing difficult problems to exercise the talents of the mathematician. Challenges of this kind frequently passed between the British and foreigners. Dr Keill of Oxford had keenly espoused the claim of Sir Isaac Newton to this invention, and had engaged in a very acrimonious altercation with the celebrated John Bernoulli of Basle. Bernoulli had published in the *Acta Eruditorum Lipsiæ* an investigation of the law of forces, by which a body moving in a resisting medium might describe any proposed curve, reducing the whole to the simplest geometry. This is perhaps the most elegant specimen which he has given of his great talents. Dr Keill proposed to him the particular problem of the trajectory and motion of a body moving through the air, as one of the most difficult. Bernoulli very soon solved the problem in a way much more general than it had been proposed, viz. without any limitation either of the law of resistance, the law of the centripetal force, or the law of density, provided only that they were regular, and capable of being expressed algebraically. Dr Brooke Taylor, the celebrated author of the Method of Increments, solved it at the same time, in the limited form in which it was proposed. Other authors since that time have given other solutions. But they are all (as indeed they must be) the same in substance with Bernoulli's. Indeed they are all (Bernoulli's not excepted) the same with Newton's first approximations, modified by the steps introduced into the investigation of the spiral motions mentioned above; and we still think it most strange that Sir Isaac did not perceive that the *variation of curvature*, which he introduced in that investigation, made the whole difference between his approximations and the complete solution. This we shall point out as we go along. And we now proceed to the problem itself, of which we shall give Bernoulli's solution, restricted to the case of uniform density and a resistance proportional to the square of the velocity. This solution is more simple and perspicuous than any that has since appeared.

73 Bernoulli's solution.

Plate CCCCXV.

Problem. To determine the trajectory, and all the circumstances of the motion, of a body projected thro' the air from A (fig. 7.) in the direction AB, and resisted in the duplicate ratio of the velocity.

Let the arch AM be put $=z$, the time of describing it t, the abscissa $AP=x$, the ordinate $PM=y$. Let the velocity in the point $M=v$, and let MN, $=\dot{z}$, be described in the moment $\dot{t}$; let r be the resistance of the air, g the force of gravity, measured by the velocity which it will generate in a second; and let a be the height through which a heavy body must fall *in vacuo* to acquire the velocity which would render the resistance of the air equal to its gravity: so that we have $r=\frac{v^2}{2a}$; because, for any velocity u, and producing height h, we have $g=\frac{u^2}{2h}$

Let Mm touch the curve in M; draw the ordinate pNm,

p N m, and draw M o, N n perpendicular to N p and M m. Then we have $MN = \dot{z}$, and $Mo = \dot{x}$, also $m\,o$ is ultimately $= \dot{y}$ and M m is ultimately $=$ MN or $\dot{z}$. Lastly, let us suppose $\dot{x}$ to be a constant quantity, the elementary ordinates being supposed equidistant.

74 The action of gravity during the time $\dot{t}$ may be measured by m N, which is half the space which it would cause the body to describe uniformly in the time $\dot{t}$ with the velocity which it generates in that time. Let this be resolved into n N, by which it deflects the body into a curvilineal path, and $m\,n$, by which it retards the ascent and accelerates the descent of the body along the tangent. The resistance of the air acts solely in retarding the motion, both in ascending and descending, and has no deflective tendency. The whole action of gravity then is to its accelerating or retarding tendency as m N to $m\,n$, or (by similarity of triangles) as m M to $m\,o$. Or $\dot{z} : \dot{y} = g : \frac{g\dot{y}}{\dot{z}}$, and the whole retardation in the ascent will be $r + \frac{g\dot{y}}{\dot{z}}$. The same fluxionary symbol will express the retardation during the descent, because in the descent the ordinates decrease, and $\dot{y}$ is a negative quantity.

The diminution of velocity is $-\dot{v}$. This is proportional to the retarding force and to the time of its action jointly, and therefore $-\dot{v} = \overline{r + \frac{g\dot{y}}{\dot{z}}} \times \dot{t}$; but the time $\dot{t}$ is as the space $\dot{z}$ divided by the velocity v; therefore $-\dot{v} = r + \frac{g\dot{y}}{\dot{z}} \times \frac{\dot{z}}{v}, = -\frac{r\dot{z} + g\dot{y}}{v}$, and $-v\dot{v} = -r\dot{z} - g\dot{y}, = \frac{v^2\dot{z}}{2a} - g\dot{y}$. Because m N is the deflection by gravity, it is as the force g and the square of the time $\dot{t}$ jointly (the momentary action being held as uniform). We have therefore m N, or $-\ddot{y} = g\dot{t}^2$. (Observe that m N is in fact only the half of $-\ddot{y}$; but g being twice the fall of a heavy body in a second, we have $-\ddot{y}$ strictly equal to $g\dot{t}^2$). But $\dot{t}^2 = \frac{\dot{z}^2}{v^2}$; therefore $-\ddot{y} = \frac{g\dot{z}^2}{v^2}$, and $v^2 = \frac{g\dot{z}^2}{-\ddot{y}}$, and $-v^2\ddot{y} = g\dot{z}^2$. The fluxion of this equation is $-v^2\dddot{y} - 2v\ddot{y}\dot{v} = 2g\dot{z}\ddot{z}$; but, because $\dot{z} : \dot{y} = m\,\mathrm{M} : m\,o, = m\,\mathrm{N} : m\,n, = \ddot{y} : \ddot{z}$, we have $\dot{z}\ddot{z} = \dot{y}\ddot{y}$. Therefore $2g\dot{y}\ddot{y} = 2g\dot{z}\ddot{z}, = -v^2\dddot{y} - 2v\ddot{y}\dot{v}$, and $-2v\dot{v}\ddot{y} = v^2\dddot{y}, -2g\dot{y}\ddot{y}$, and $-v\dot{v} = \frac{v^2\dddot{y}}{2\ddot{y}} - g\dot{y}$. But we have already $-v\dot{v} = \frac{v^2\dot{z}}{2a} - g\dot{y}$; therefore $\frac{v^2\dddot{y}}{\ddot{y}} = \frac{v^2\dot{z}}{a}$, and finally $\frac{\dddot{y}}{\ddot{y}} = \frac{\dot{z}}{a}$, or $a\dddot{y} = \dot{z}\ddot{y}$, for the fluxionary equation of the curve.

If we put this into the form of a proportion, we have $a : \dot{z} = \ddot{y} : \dddot{y}$. Now this evidently establishes a relation between the length of the curve and its variation of curvature; and between the curve itself and its evoluta, which are the very circumstances introduced by Newton into his investigation of the spiral motions. And the equation $\frac{\dot{z}}{a} = \frac{\dddot{y}}{\ddot{y}}$ is evidently an equation connected with the logarithmic curve and the logarithmic spiral. But we must endeavour to reduce it to a lower order of fluxions, before we can establish a relation between z, x, and y. 75 Relation between the length of the curve and its variation of curvature.

Let p express the ratio of $\dot{y}$ to $\dot{x}$, that is, let p be $= \frac{\dot{y}}{\dot{x}}$, or $p\dot{x} = \dot{y}$. It is evident that this expresses the inclination of the tangent at M to the horizon, and that p is the tangent of this inclination, radius being unity. Or it may be considered merely as a number, multiplying $\dot{x}$, so as to make it $= \dot{y}$. We now have $\dot{y}^2 = p^2\dot{x}^2$, and since $\dot{z}^2 = \dot{x}^2 + \dot{y}^2$, we have $\dot{z}^2 = \dot{x}^2 + p^2\dot{x}^2, = \overline{1 + p^2} \times \dot{x}^2$ and $\dot{z} = \dot{x}\sqrt{1 + p^2}$.

Moreover, because we have supposed the abscissa x to increase uniformly, and therefore $\dot{x}$ to be constant, we have $\ddot{y} = \dot{x}\dot{p}$, and $\dddot{y} = \dot{x}\ddot{p}$. Now let q express the ratio of $\dot{p}$ to $\dot{x}$, that is, make $\frac{\dot{p}}{\dot{x}} = q$, or $q\dot{x} = \dot{p}$. This gives us $\dot{x}\dot{q} = \ddot{p}$, and $\dot{x}^2\dot{q} = \dot{x}\ddot{p}, = \dddot{y}$.

By these substitutions our former equation $a\dddot{y} = \dot{z}\ddot{y}$ changes to $a\dot{x}^2\dot{q} = \dot{x}\sqrt{\overline{1 + p^2}}\,\dot{x}\dot{p}$, or $a\dot{q} = \dot{p}\sqrt{1 + p^2}$, and, taking the fluent on both sides, we have $aq = \int \dot{p}\sqrt{1 + p^2} + \mathrm{C}$, C being the constant quantity required for completing the fluent according to the limiting conditions of the case. Now $\dot{x} = \frac{\dot{p}}{q}$, and $\frac{1}{q} = \frac{a}{\int, \dot{p}\sqrt{\overline{1 + p^2}} + \mathrm{C}}$. Therefore $\dot{x} = \frac{a\dot{p}}{\int, \dot{p}\sqrt{\overline{1 + p^2}} + \mathrm{C}}$

Also, since $\dot{y} = p\dot{x}, = \frac{p\dot{p}}{q}$, we have $y = \int, \frac{ap\dot{p}}{\int, \dot{p}\sqrt{\overline{1 + p^2}} + \mathrm{C}}$

Also $\dot{z} = \dot{x}\sqrt{1 + p^2} = \frac{a\dot{p}\sqrt{1 + p^2}}{\int, \dot{p}\sqrt{\overline{1 + p^2}} + \mathrm{C}}$

The values of $\dot{x}$, $\dot{y}$, $\dot{z}$, give us

$$x = \int, \frac{a\dot{p}}{\int, \dot{p}\sqrt{\overline{1 + p^2}} + \mathrm{C}}, = a\int \frac{\dot{p}}{\int \dot{p}\sqrt{\overline{1 + p^2}} + \mathrm{C}}.$$

$$y = f \frac{a p \dot{p}}{f, p\sqrt{1+p^2}| + C}, = a f \frac{p \dot{p}}{f, \dot{p}\sqrt{1+p^2}| + C}.$$

$$z = f, \frac{a\sqrt{1+p^2}|\dot{p}}{f, \dot{p}\sqrt{1+p^2}| + C}, = a \frac{f\, \dot{p}\sqrt{1+p^2}}{f, \dot{p}\sqrt{1+p^2}| + C}.$$

The proceſs therefore of deſcribing the trajectory is, 1*ſt*. To find q in terms of p by the area of the curve whoſe abſciſſa is p and the ordinate is $\sqrt{1+p^2}$.

2*d*, We get x by the area of another curve whoſe abſciſſa is p, and the ordinate is $\frac{1}{q}$.

3*d*, We get y by the area of a third curve whoſe abſciſſa is p, and the ordinate is $\frac{p}{q}$.

The problem of the trajectory is therefore completely ſolved, becauſe we have determined the ordinate, abſciſſa, and arch of the curve for any given poſition of its tangent. It now only remains to compute the magnitudes of theſe ordinates and abſciſſæ, or to draw them by a geometrical conſtruction. But in this conſiſts the difficulty. The areas of theſe curves, which expreſs the lengths of x and y, can neither be computed nor exhibited geometrically, by any accurate method *yet* diſcovered, and we muſt content ourſelves with approximations. Theſe render the deſcription of the trajectory exceedingly difficult and tedious, ſo that little advantage has as yet been derived from the knowledge we have got of its properties. It will however greatly aſſiſt our conception of the ſubject to proceed ſome length in this conſtruction; for it muſt be acknowledged that very few diſtinct notions accompany a mere algebraic operation, eſpecially if in any degree complicated, which we confeſs is the caſe in the preſent queſtion.

76 To compute the magnitude of the ordinate and abſciſſa.

Plate CCCCXVIII.

Let B m N R (fig. 8.) be an equilateral hyperbola, of which B is the vertex, BA the ſemitranſverſe axis, which we ſhall aſſume for the unity of length. Let AV be the ſemiconjugate axis $=$ BA, $=$ unity, and AS the aſſymptote, biſecting the right angle BAV. Let PN, pn be two ordinates to the conjugate axis, exceedingly near to each other. Join BP, AN, and draw Bβ, Nν perpendicular to the aſſymptote, and BC parallel to AP. It is well known that BP is equal to NP. Therefore $PN^2 = BA^2 + AP^2$. Now ſince $BA = 1$, if we make $AP = p$ of our formulæ, PN is $\sqrt{1+p^2}$, and Pp is $= \dot{p}$, and the area BAPNB $= f, \dot{p}\sqrt{1+p^2}|$: That is to ſay, the number $f, \dot{p}\sqrt{1+p^2}$ (for it is a number) has the ſame proportion to unity of number that the area BAPNB has to BCVA, the unit of ſurface. This area conſiſts of two parts, the triangle APN, and the hyperbolic ſector ABN. $APN = \frac{1}{2} AP \times PN, = \frac{1}{2} p\sqrt{1+p^2}$, and the hyperbolic ſector ABN $=$ BN$\nu\beta$, which is equivalent to the hyperbolic logarithm of the number repreſented by Aν when Aβ is unity. Therefore it is equal to $\frac{1}{2}$ the logarithm of $p + \sqrt{1+p^2}$. Hence we ſee by the bye that $f, \dot{p}\sqrt{1+p^2} = \frac{1}{2} p\sqrt{1+p^2} + \frac{1}{2}$ hyperbolic logarithm $\overline{p+\sqrt{1+p^2}}$.

Now let AMD be another curve, ſuch that its ordinates Vm, PD, &c. may be proportional to the areas ABmV, ABNP, and may have the ſame proportion to AB, the unity of length, which theſe areas have to ABCV, the unity of ſurface. Then VM : VC $=$ Vm BA : VCBA and PD : Pδ $=$ PNBA : VCBA, &c. Theſe ordinates will now repreſent $f, \dot{p}\sqrt{1+p^2}$ with reference to a linear unit, as the areas to the hyperbola repreſented it in reference to a ſuperficial unit.

Again, in every ordinate make PD : Pδ $=$ Pδ : PO, and thus we obtain a reciprocal to PD or to $f, \dot{p}\sqrt{1+p^2}$, or equivalent to $f, \frac{1}{\dot{p}\sqrt{1+p^2}}$. This will evidently be $\frac{\dot{x}}{ap}$, and POop will be $\frac{\dot{x}}{a}$, and the area contained between the lines AF, AW, and the curve GEOH, and cut off by the ordinate PO, will repreſent $\frac{x}{a}$.

Laſtly, make PO : PQ $=$ AV : AP, $= 1 : p$; and then PQ qp will repreſent $\frac{\dot{y}}{a}$, and the area ALEQP will repreſent $\frac{y}{a}$.

But we muſt here obſerve, that the fluents expreſſed by theſe different areas require what is called the *correction* to accommodate them to the circumſtances of the caſe. It is not indifferent from what ordinate we begin to reckon the areas. This depends on the initial direction of the projectile, and that point of the abſciſſa AP muſt be taken for the commencement of all the areas which gives a value of p ſuited to the initial direction. Thus, if the projection has been made from A (fig. 7.) at an elevation of 45°, the ratio of the fluxions $\dot{x}$ and $\dot{y}$ is that of equality; and therefore the point E of fig. 8. where the two curves interſect and have a common ordinate, evidently correſponds to this condition. The ordinate EV paſſes through V, ſo that AV or $p =$ AB, $= 1$, $=$ tangent 45°, as the caſe requires. The values of x and of y correſponding to any other point of the trajectory, ſuch as that which has AP for the tangent of the angle which it makes with the horizon, are now to be had by computing the areas VEOP, VEQP.

Plate CCCCXVII. Plate CCCCXVIII.

Another curve might have been added, of which the ordinates would exhibit the fluxions of the arch of the trajectory $\dot{z} = \frac{a\dot{p}\sqrt{1+p^2}}{f, \dot{p}\sqrt{1+p^2}| + C}$ and of which the area would exhibit the arch itſelf. And this would have been very eaſy, for it is $\dot{z} = a \frac{\dot{p}\sqrt{1+p^2}}{f, \dot{p}\sqrt{1+p^2}| + C}$, which is evidently the fluxion of the hyperbolic logarithm of $f, \dot{p}\sqrt{1+p^2}|$. But it is needleſs, ſince $\dot{z} = \dot{x}\sqrt{1+p^2}$, and we have already got $\dot{x}$. It is only increaſing PO in the ratio of BA to BP.

77 Conſequences of knowing the form of the trajectory.

And thus we have brought the inveſtigation of this problem a conſiderable length, having aſcertained the *form* of the trajectory. This is ſurely done when the ratio of the arch, abſciſs, and ordinate, and the poſition of its tangent, is determined in every point. But it is ſtill very far from a ſolution, and much remains to be done before we can make any practical application of it. The only general conſequence that we can deduce from the premiſes

ses is, that in every case where the resistance in any point bears the same proportion to the force of gravity, the trajectory will be similar. Therefore two balls, of the same density, projected in the same direction, will describe similar trajectories if the velocities are in the subduplicate ratio of the diameters. This we shall find to be of considerable practical importance. But let us now proceed to determine the velocity in the different points of the trajectory, and the time of describing its several portions.

78 deter- ...e the ...city in ...erent ...nts.

Recollect, therefore, that $v^2 = \frac{-g\dot{z}^2}{\ddot{y}}$ and that $\dot{z}^2 = \dot{x}^2\,\overline{1+p^2}$ and $\ddot{y} = \dot{x}\dot{p}$. This gives $v^2 = \frac{-g\dot{x}\,\overline{1+p^2}}{\dot{p}}$. But $\dot{p} = q\dot{x}$. Therefore $v^2 = \frac{-g\times\overline{1+p^2}}{q}, = \frac{-ag\,\overline{1+p^2}}{\int,\dot{p}\sqrt{1+p^2}+C}$, and $v = \sqrt{\frac{-g\,\overline{1+p^2}}{q}}, = \frac{\sqrt{a}\sqrt{-g}\sqrt{1+p^2}}{\sqrt{\int\dot{p}\sqrt{1+p^2}|+C}}$.

Also $\dot{t}$ was found $=\frac{\dot{z}}{v}, = \frac{\dot{x}\sqrt{1+p^2}}{v}, = \frac{\dot{p}\sqrt{1+p^2}}{qv}$. If we now substitute for v its value just found, we obtain $\dot{t} = \frac{\dot{p}}{\sqrt{-gq}}$, and $t = \int\frac{\dot{p}}{\sqrt{-gq}}$

$$= \int\frac{\dot{p}\sqrt{a}}{\sqrt{-g\int\dot{p}\sqrt{1+p^2}|+C}}, = \frac{\sqrt{a}}{\sqrt{-g}}\times\int\frac{\dot{p}}{\sqrt{\int\dot{p}\sqrt{1+p^2}|+C}}.$$

79 ...ficulty accom- ...dating formu- to par- ...lar ...es.

The greatest difficulty still remains, viz. the accommodating these formulæ, which appear abundantly simple, to the particular cases. It would appear at first sight, that all trajectories are similar; since the ratio of the fluxions of the ordinate and abscissa corresponding to any particular angle of inclination to the horizon seems the same in them all: but a due attention to what has been hitherto said on the subject will show us that we have as yet only been able to ascertain the velocity in the point of the trajectory, which has a certain inclination to the horizon, indicated by the quantity p, and the time (reckoned from some assigned beginning) when the projectile is in that point.

To obtain absolute measures of these quantities, the term of commencement must be fixed upon. This will be expressed by the constant quantity C, which is assumed for completing the fluent of $\dot{p}\sqrt{1+p^2}$, which is the basis of the whole construction. We there found $q = \frac{\int,\dot{p}\sqrt{1+p^2}}{a}$. This fluent is in general $q = \frac{C+\int,\dot{p}\sqrt{1+p^2}}{a}$, and the constant quantity C is to be accommodated to some circumstances of the case. Different authors have selected different circumstances. Euler, in his Commentary on Robins, and in a dissertation in the Memoirs of the Academy of Berlin published in 1753, takes the vertex of the curve for the beginning of his abscissa and ordinate. This is the simplest method of any, for C must then be so chosen that the whole fluent may vanish when $p=0$, which is the case in the vertex of the curve, where the tangent is parallel to the horizon. We shall adopt this method.

80 ...er's me- ...the ...plest.

Therefore, let AP (fig. 9.) $=x$, PM $=y$, AM $=z$. Plate CCCCXVIII.
Put the quantity C which is introduced into the fluent equal to $\frac{n}{a}$. It is plain that n must be a number; for it must be homologous with $\dot{p}\sqrt{1+p^2}$, which is a number. For brevity's sake let us express the fluent of $\dot{p}\sqrt{1+p^2}$ by the single letter P; and thus we shall have $x = a\times\int\frac{\dot{p}}{n+P}$, $y = a\times\int\frac{p\dot{p}}{n+P}$, $z = a\times\int\frac{\dot{p}\sqrt{1+p^2}}{n+P}$. And $v^2 = \frac{-ag(1+p^2)}{n+P}$. Now the height h necessary for communicating any velocity v is $\frac{v^2}{2g} = \frac{-ag(1+p^2)}{2g(n+P)}, = \frac{-\frac{1}{2}a(1+p^2)}{n+P}$. And lastly, $t = \frac{\sqrt{a}}{\sqrt{g}}\int\frac{\dot{p}}{\sqrt{n+P}}$.

These fluents, being all taken so as to vanish at the vertex, where the computation commences, and where p is $=0$ (the tangent being parallel to the horizon), we obtain in this case $h = \frac{\frac{1}{2}a}{n}, = \frac{a}{2n}$, and $n = \frac{a}{2h}$.

Hence we see that the circumstance which modifies all the curves, distinguishing them from each other, is the velocity (or rather its square) in the highest point of the curve. For h being determined for any body whose terminal velocity is u, n is also determined; and this is the modifying circumstance. Considering it geometrically, it is the area which must be cut off from the area DMAP of fig. 8. in order to determine the ordinates of the other curves.

We must farther remark, that the values now given relate only to that part of the area where the body is descending from the vertex. This is evident; for, in order that y may increase as we recede from the vertex, its fluxion must be taken in the opposite sense to what it was in our investigation. *There* we supposed y to increase as the body ascended, and then to diminish during the descent; and therefore the fluxion of y was first positive and then negative.

The same equations, however, will serve for the ascending branch CNA of the curve, only changing the sign of P; for if we consider y as decreasing during the ascent, we must consider q as expressing $\frac{-\dot{p}}{\dot{x}}$, and therefore P, or $\int\dot{p}\sqrt{1+p^2}$, which is $=\frac{q}{a}$, must be taken negatively. Therefore, in the ascending branch, we have AQ or x (increasing as we recede from A) $= a\times\int\frac{\dot{p}}{n-P}$, QN or $y = a\times\int\frac{p\dot{p}}{n-P}$, AN or $z = a\times\int\frac{\dot{p}\sqrt{1+p^2}}{n-P}$, $t = \frac{\sqrt{a}}{\sqrt{g}}\times\int\frac{\dot{p}}{\sqrt{1-P}}$, and the height producing the velocity at N $= \frac{\frac{1}{2}a(1+p^2)}{n-P}$.

81 Remarkable property of the curve or trajectory.

Hence we learn by the bye, that in no part of the ascending branch can the inclination of the tangent be

fuch that P fhall be greater than n; and that if we fuppofe P equal to n in any point of the curve, the velocity in that point will be infinite. That is to fay, there is a certain affignable elevation of the tangent which cannot be exceeded in a curve which has this velocity in the vertex. The beft way for forming a conception of this circumftance in the nature of the curve, is to invert the motion, and fuppofe an accelerating force equal and oppofite to the refiftance, to act on the body in conjunction with gravity. It muft defcribe the fame curve, and this branch ANC muft have an affymptote LO, which has this limiting pofition of the tangent. For, as the body defceads in this curve, its velocity increafes to infinity by the joint action of gravity and this *accelerating* force, and yet the tangent never approaches fo near the perpendicular pofition as to make $P=n$. This remarkable property of the curve was known to Newton, as appears by his approximations, which all lead him to curves of a hyperbolic form, having one affymptote inclined to the horizon. Indeed it is pretty obvious: For the refiftance increafing fafter than the velocity, there is no velocity of projection fo great but that the curve will come to deviate fo from the tangent, that in a finite time it will become parallel to the horizon. Were the refiftance proportional to the velocity, then an infinite velocity would produce a rectilineal motion, or rather a deflection from it lefs than any that can be affigned.

82 On what its form and magnitude depends.

We now fee that the particular form and magnitude of this trajectory depends on two circumftances, a and n. a affects chiefly the magnitude. Another circumftance might indeed be taken in, viz. the diminution of the accelerating force of gravity by the ftatical effect of the air's gravity. But, as we have already obferved, this is too trifling to be attended to in military projectiles.

$\frac{\dot{y}}{\dot{x}}$ was made equal to $\dot{p}$. Therefore the radius of curvature, determined by the ordinary methods, is $\frac{\dot{x}(1+p^2)(\sqrt{1+p^2})}{\dot{p}}$ *, and, becaufe $\frac{\dot{x}}{\dot{p}}$ is $=\frac{a}{n+P}$ for the defcending branch of the curve, the radius of curvature at M is $\frac{a\times\overline{1+p^2}\times\sqrt{1+p^2}}{n+P}$, and, in the afcending branch at N, it is $\frac{a\times\overline{1+p^2}\times\sqrt{1+p^2}}{n-P}$. On both fides therefore, when the velocity is infinitely great, and P by this means fuppofed to equal or exceed n, the radius of curvature is alfo infinitely great. We alfo fee that the two branches are unlike each other, and that when p is the fame in both, that is, when the tangent is equally inclined to the horizon, the radius of curvature, the ordinate, the abfcifs, and the arch, are all greater in the afcending branch. This is pretty obvious. For as the refiftance acts entirely in diminifhing the velocity, and does not affect the deflection occafioned by gravity, it muft allow gravity to incurvate the path fo much the more (with the fame inclination of its line of action) as the velocity is more diminifhed. The curvature, therefore, in thofe points which have the fame inclination of the tangent, is greateft in the defcending branch, and the motion is fwifteft in the afcending branch. It is otherwife in a void, where both fides are alike. Here u becomes infinite, or there is no terminal velocity; and n alfo becomes infinite, being $=\frac{a}{2b}$.

* Simpfon's Fluxions, § 68, &c.

It is therefore in the quantity P, or $\int \dot{p}\sqrt{1+p^2}$, that the difference between the trajectory in a void and in a refifting medium confifts; it is this quantity which expreffes the accumulated change of the ratio of the increments of the ordinate and abfcifs. In vacuo the fecond increment of the ordinate is conftant when the firft increment of the abfciffa is fo, and the whole increment of the ordinate is as $1+p$. And this difference is fo much the greater as P is greater in refpect of n. P is nothing at the vertex, and increafes along with the angle MTP; and when this is a right angle, P is infinite. The trajectory in a refifting medium will come therefore to deviate infinitely from a parabola, and may even deviate farther from it than the parabola deviates from a ftraight line. That is, the diftance of the body in a given moment from that point of its parabolic path where it would have been in a void, is greater than the diftance between that point of the parabola from the point of the ftraight line where it would have been, independent of the action of gravity. This muft happen whenever the refiftance is greater than the weight of the body, which is generally the cafe in the beginning of the trajectory in military projectiles; and this (were it now neceffary) is enough to fhow the inutility of the parabolic theory.

83 Several properties of it afcertained.

Although we have no method of defcribing this trajectory, which would be received by the ancient geometers, we may afcertain feveral properties of it, which will affift us in the folution of the problem. In particular, we can affign the abfolute length of any part of it by means of the logiftic curve. For becaufe $P=\int \dot{p}\sqrt{1+p^2}$, we have $\dot{p}\sqrt{1+p^2}=\dot{P}$, and therefore z, which was $=a\times\int\frac{\dot{p}\sqrt{1+p^2}}{\int\dot{p}\sqrt{1+p^2}}+C$, or $=a\times\int\frac{\dot{P}}{n+P}$, may be expreffed by logarithms; or $z=a\times$ hyp. log. of $\frac{n+P}{n}$, fince at the vertex A, where z muft be $=o$, P is alfo $=o$.

Being able, in this way, to afcertain the length AM of the curve (counted from the vertex), correfponding to any inclination p of the tangent at its extremity M, we can afcertain the length of any portion of it, fuch as Mm, by firft finding the length of the part Am, and then of the part AM. This we do more expeditioufly thus: Let p exprefs the pofition of the tangent in M, and q its pofition at m; then $AM=a\times\log.\frac{n+P}{n}$ and $Am=a\times\log.\frac{n+Q}{n}$, and therefore M$m$ is $=a\times\log.\frac{n+Q}{n+P}$. Thus we can find the values of a great number of fmall portions, and the inclination of the tangents at their extremities. Then to each of thefe portions we can affign its proportion of the abciffa and ordinate, without having recourfe to the values of x and y. For the portion of abfcifs correfponding to the arch Mm, whofe

whose middle point is inclined to the horizon in the angle b, will be $Mm \times$ cosine b, and the corresponding portion of the ordinate will be $Mm \times$ sin. b. Then we obtain the velocity in each part of the curve by the equation $h = \frac{\frac{1}{2}a \times \overline{1+p^2}}{n+p}$; or, more directly the velocity v at M will be $= \sqrt{ag} \frac{\sqrt{1+p^2}}{\sqrt{n+P}}$. Lastly, divide the length of the little arch by this, and the quotient will be the time of describing Mm very nearly. Add all these together, and we obtain the whole time of describing the arch AM, but a little too great, because the motion in the small arch is not perfectly uniform. The error, however, may be as small as we please, because we may make the arch as small as we please; and for greater accuracy, it will be proper to take the p by which we compute the velocity, a medium between the p for the beginning and that for the end of the arch.

84 ...'s me- ... pre- ...ed.

This is the method followed by Euler, who was one of the most expert analysts, if not the very first, in Europe. It is not the most elegant, and the methods of some other authors, who approximate directly to the areas of the curves which determine the values of x and y, have a more scientific appearance; but they are not ultimately very different: For, in some methods, these areas are taken piecemeal, as Euler takes the arch; and by the methods of others, who give the value of the areas by Newton's method of describing a curve of the parabolic kind through any number of given points, the ordinates of these curves, which express $\dot{x}$ and $\dot{y}$, must be taken singly, which amounts to the same thing, with the great disadvantage of a much more complicated calculus, as any one may see by comparing the expressions of x and y with the expression of z. As to those methods which approximate directly to the areas or values of x and y by an infinite series, they all, without exception, involve us in most complicated expressions, with coefficients of sines and tangents, and ambiguous signs, and engage us in a calculation almost endless. And we know of no series which converges fast enough to give us tolerable accuracy, without such a number of terms as is sufficient to deter any person from the attempt. The calculation of the arches is very moderate, so that a person tolerably versant in arithmetical operations may compute an arch with its velocity and time in about five minutes. We have therefore no hesitation in preferring this method of Euler's to all that we have seen, and therefore proceed to determine some other circumstances which render its application more general.

85 ...applica- ...made ...re gene-

If there were no resistance, the smallest velocity would be at the vertex of the curve, and it would immediately increase by the action of gravity conspiring (in however small degree) with the motion of the body. But in a resisting medium, the velocity at the vertex is diminished by a quantity to which the acceleration of gravity in that point bears no assignable proportion. It is therefore diminished, upon the whole, and the point of smallest velocity is a little way beyond the vertex. For the same reasons, the greatest curvature is a little way beyond the vertex. It is not very material for our present purpose to ascertain the exact positions of those points.

The velocity in the descending branch augments continually: but it cannot exceed a certain limit, if the velocity at the vertex has been less than the terminal velocity; for when the curve is infinite, p is also infinite, and $h = \frac{\frac{1}{2}ap^2}{P}$, because n in this case is nothing in respect of P, which is infinite; and because p is infinite, the number hyp. log. $p + \sqrt{1+p^2}$, though infinite, vanishes in comparison with $p \times \sqrt{1+p^2}$; so that in this case $P = \frac{1}{2}p^2$, and $h = a$, and $v =$ the terminal velocity.

If, on the other hand, the velocity at the vertex has been greater than the terminal velocity, it will diminish continually, and when the curve has become infinite, v will be equal to the terminal velocity.

In either case we see that the curve on this side will have a perpendicular assymptote. It would require a long and pretty intricate analysis to determine the place of this assymptote, and it is not material for our present purpose. The place and position of the other assymptote LO is of the greatest moment. It evidently distinguishes the kind of trajectory from any other. Its position depends on this circumstance, that if p marks the position of the tangent, $n-P$, which is the denominator of the fraction expressing the square of the velocity, must be equal to nothing, because the velocity is infinite: therefore, in this place, $P = n$, or $n = \frac{1}{2}p\sqrt{1+p^2} + \frac{1}{2}\log. p + \sqrt{1+p^2}$. In order, therefore, to find the point L, where the assymptote LO cuts the horizontal line AL, put $P = n$, then will $AL = x - \frac{y\dot{x}}{\dot{y}}, = a \times \left(\int \frac{\dot{p}}{n-P} - \frac{1}{p} \int \frac{p\dot{p}}{n-P} \right)$. Through the whole of this article $\int$ means fluent.

It is evident that the logarithms used in these expressions are the natural or hyperbolic. But the operations may be performed by the common tables by making the value of the arch Mm of the curve $= \frac{a}{M} \times \log. \frac{n+Q}{n+P}$ &c. where M means the subtangent of the common logarithms, or 0,43429; also the time of describing this arch will be expeditiously had by taking a medium μ between the values of $\frac{\sqrt{1+p^2}}{\sqrt{n+P}}$ and $\frac{\sqrt{1+q^2}}{\sqrt{n+Q}}$, and making the time $= \frac{\sqrt{a}}{M\mu\sqrt{g}} \times \log. \frac{n+Q}{n+P}$.

Such then is the process by which the form and magnitude of the trajectory, and the motion in it, may be determined. But it does not yet appear how this is to be applied to any question in practical artillery. In this process we have only learned how to compute the motion from the vertex in the descending branch till the ball has acquired a particular direction, and the motion to the vertex from a point of the ascending branch where the ball has another direction, and all this depending on the greatest velocity which the body can acquire by falling, and the velocity which it has in the vertex of the curve. But the usual question is, "What will be the motion of the ball projected in a certain direction with a certain velocity?" 86 Mode of applying this process in practice.

The mode of application is this: Suppose a trajectory computed for a particular terminal velocity, produced by the fall a, and for a particular velocity at the vertex, which

which will be characterized by n, and that the velocity at that point of the ascending branch where the inclination of the tangent is 30° is 900 feet *per* second. Then, we are certain that if a ball, whose terminal velocity is that produced by the fall a, be projected with the velocity of 900 feet per second, and an elevation of 30°, it will describe this very trajectory, and the velocity and time corresponding to every point will be such as is here determined.

Now this trajectory will, in respect to form, answer an infinity of cases: for its characteristic is the proportion of the velocity in the vertex to the terminal velocity. When this proportion is the same, the number n will be the same. If therefore we compute the trajectories for a sufficient variety of these proportions, we shall find a trajectory that will nearly correspond to any case that can be proposed; and an approximation sufficiently exact will be had by taking a proportional medium between the two trajectories which come nearest to the case proposed.

87 Computed tables or trajectories.

Accordingly, a set of tables or trajectories have been computed by the English translator of Euler's Commentary on Robins's Gunnery. They are in number 18, distinguished by the position of the assymptote of the ascending branch. This is given for 5°, 10°, 15°, &c. to 85°, and the whole trajectory is computed as far as it can ever be supposed to extend in practice. The following table gives the value of the number n corresponding to each position of the assymptote.

OLB	n	OLB	n
0	0,00000	45	1,14779
5	0,08760	50	1,43236
10	0,17724	55	1,82207
15	0,27712	60	2,39033
20	0,37185	65	3,29040
25	0,48269	70	4,88425
30	0,60799	75	8,22357
35	0,75382	80	17,54793
40	0,92914	85	67,12291

Since the path of a projectile is much less incurvated, and more rapid in the ascending than in the descending branch, and the difference is so much the more remarkable in great velocities; it must follow, that the range on a horizontal or inclined plane depends most on the ascending branch: therefore the greatest range will not be made with that elevation which bisects the angle of position, but with a lower elevation; and the deviation from the bisecting elevation will be greater as the initial velocities are greater. It is very difficult to frame an exact rule for determining the elevation which gives the greatest range. We have subjoined a little table which gives the proper elevations (nearly) corresponding to the different initial velocities.

It was computed by the following approximation, which will be found the same with the series used by Newton in his Approximations.

Let e be the angle of elevation, a the height producing the terminal velocity, b the height producing the initial velocity, and c the number whose hyperbolic logarithm is 1 (*i. e.* the number 2,718). Then,

$$y = x \times \left(\text{tan. } e + \frac{a}{2 b. \text{ cos. } e}\right) - \frac{a^2}{2 b}\left(C^{\frac{x}{a. \text{ cos. } e.}} - 1\right),$$

&c. Make $y = v$, and take the maximum by varying e, we obtain $\frac{1}{\text{Sin.}^2 e + \frac{a. \text{ sin. } e}{2 b}} =$ hyperbol. log. $\left(1 + \frac{2 b}{a \text{ sine } e}\right)$, which gives us the angle e.

The numbers in the first column, multiplied by the terminal velocity of the projectile, give us the initial velocity; and the numbers in the last column, being multiplied by the height producing the terminal velocity, and by 2,3026, give us the greatest ranges. The middle column contains the elevation. The table is not computed with scrupulous exactness, the question not requiring it. It may however be depended on within one part of 2000.

To make use of this table, divide the initial velocity by the terminal velocity u, and look for the quotient in the first column. Opposite to this will be found the elevation giving the greatest range; and the number in the last column being multiplied by 2,3026 × a (the height producing the terminal velocity) will give the range.

Table of Elevations giving the greatest Range.

Initial vel. u	Elevation.	Range. $2{,}3026a'$
0,6909	43°.40′	0,1751
0,7820	43 .20	0,2169
0,8645	42 .50	0,2548
1,3817	41 .40	0,4999
1,5641	40.20	0,5789
1,7291	40.10	0,6551
2,0726	39.50	0,7877
2,3461	37.20	0,8967
2,5936	35.50	0,9752
2,7635	35.—	1,0319
3,1281	34.40	1,1411
3,4544	34.20	1,2298
3,4581	34.20	1,2277
3,9101	33.50	1,3371
4,1452	33.30	1,3901
4,3227	33.30	1,4274
4,6921	31.50	1,5050
4,8361	31.50	1,5341

Such is the solution which the present state of our mathematical knowledge enables us to give of this celebrated problem. It is exact in its principle, and the application of it is by no means difficult, or even operose. But let us see what advantage we are likely to derive from it. 88 Advantages to be derived from the solution of the problem.

In the first place, it is very limited in its application. There are few circumstances of general coincidence, and almost every case requires an appropriated calculus. Perhaps the only general rules are the two following:

1. Balls of equal density, projected with the same elevation, and with velocities which are as the square-roots of their diameters, will describe similar curves.— This is evident, because, in this case, the resistance will be in the ratio of their quantities of motion. Therefore all

all the homologous lines of the motion will be in the proportion of the diameters.

2. If the initial velocities of balls projected with the ſame elevation are in the inverſe ſubduplicate ratio of the whole reſiſtances, the ranges, and all the homologous lines of their track, will be inverſely as thoſe reſiſtances.

Theſe theorems are of conſiderable uſe: for by means of a proper ſeries of experiments on one ball projected with different elevations and velocities, tables may be conſtructed which will aſcertain the motions of an infinity of others.

89
wn
n va-
s con-
ratiors
e very
e.

But when we take a retroſpective view of what we have done, and conſider the conditions which were aſſumed in the ſolution of the problem, we ſhall find that much yet remains before it can be rendered of great practical uſe, or even ſatisfy the curioſity of the man of ſcience. The reſiſtance is all along ſuppoſed to be in the duplicate ratio of the velocity; but even theory points out many cauſes of deviation from this law, ſuch as the preſſure and condenſation of the air, in the caſe of very ſwift motions; and Mr Robins's experiments are ſufficient to ſhow us that the deviations muſt be exceedingly great in ſuch caſes. Mr Euler and all ſubſequent writers have allowed that it may be three times greater, even in caſes which frequently occur; and Euler gives a rule for aſcertaining with tolerable accuracy what this increaſe and the whole reſiſtance may amount to. Let H be the height of a column of air whoſe weight is equivalent to the reſiſtance taken in the duplicate ratio of the velocity. The whole reſiſtance will be expreſſed by $H + \frac{H^2}{28845}$. This number 28845 is the height in feet of a column of air whoſe weight balances its elaſticity. We ſhall not at preſent call in queſtion his reaſons for aſſigning this preciſe addition. They are rather reaſons of arithmetical conveniency than of phyſical import. It is enough to obſerve, that if this meaſure of the reſiſtance is introduced into the proceſs of inveſtigation, it is totally changed; and it is not too much to ſay, that with this complication it requires the knowledge and addreſs of a Euler to make even a partial and very limited approximation to a ſolution.— Any law of the reſiſtance, therefore, which is more complicated than what Bernoulli has aſſumed, namely, that of a ſimple power of the velocity, is abandoned by all the mathematicians, as exceeding their abilities; and they have attempted to avoid the error ariſing from the aſſumption of the duplicate ratio of the velocity, either by ſuppoſing the reſiſtance throughout the whole trajectory to be greater than what it is in general, or they have divided the trajectory into different portions, and aſſigned different reſiſtances to each, which vary, through the whole of that portion, in the duplicate ratio of the velocities. By this kind of patchwork they make up a trajectory and motion which correſponds, in ſome tolerable degree, with what? With an accurate theory? No; but with a ſeries of experiments. For, in the firſt place, every theoretical computation that we make, proceeds on a ſuppoſed initial velocity; and this cannot be aſcertained with any thing approaching to preciſion, by any theory of the action of gunpowder that we are yet poſſeſſed of. In the next place, our theories of the reſiſting power of the air are entirely eſtabliſhed on the experiments on the flights of ſhot and ſhells, and are corrected and amended till they tally with the moſt approved experiments we can find. We do not learn the ranges of a gun by theory, but the theory by the range of the gun. Now the variety and irregularity of all the experiments which are appealed to are ſo great, and the acknowledged difference between the reſiſtance to ſlow and ſwift motions is alſo ſo great, that there is hardly any ſuppoſition which can be made concerning the reſiſtance, that will not agree in its reſults with many of thoſe experiments. It appears from the experiments of Dr Hutton of Woolwich, in 1784, 1785, and 1786, that the ſhots frequently deviated to the right or left of their intended track 200, 300, and ſometimes 400 yards. This deviation was quite accidental and anomalous, and there can be no doubt but that the ſhot deviated from its intended and *ſuppoſed* elevation as much as it deviated from the intended vertical plane, and this without any opportunity of meaſuring or diſcovering the deviation. Now, when we have the whole range from one to three to chooſe among for our meaſure of reſiſtance, it is evident that the confirmations which have been drawn from the ranges of ſhot are but feeble arguments for the truth of any opinion. Mr Robins finds his meaſures fully confirmed by the experiments at Metz and at Minorca. Mr Muller finds the ſame. Yet Mr Robins's meaſure both of the initial velocity and of the reſiſtance are at leaſt treble of Mr Muller's; but by compenſation they give the ſame reſults. The Chevalier Borda, a very expert mathematician, has adduced the very ſame experiments in ſupport of his theory, in which he abides by the Newtonian meaſure of the reſiſtance, which is about $\frac{1}{3}$ of Mr Robins's, and about $\frac{3}{2}$ of Muller's.

What are we to conclude from all this? Simply this, that we have hardly any knowledge of the air's reſiſtance, and that even the ſolution given of this problem has not as yet greatly increaſed it. Our knowledge conſiſts only in thoſe experiments, and mathematicians are attempting to patch up ſome notion of the motion of a body in a reſiſting medium, which ſhall tally with them. 90 Cauſes of its inutility.

There is another eſſential defect in the conditions aſſumed in the ſolution. The denſity of the air is ſuppoſed uniform; whereas we are certain that it is leſs by one fifth or one ſixth towards the vertex of the curve, in many caſes which frequently occur, than it is at the beginning and end of the flight. This is another latitude given to authors in their aſſumptions of the air's reſiſtance. The Chevalier de Borda has, with conſiderable ingenuity, accommodated his inveſtigation to this circumſtance, by dividing the trajectory into portions, and, without much trouble, has made one equation anſwer them all. We are diſpoſed to think that his ſolution of the problem (in the Memoirs of the Academy of Paris for 1769) correſponds better with the phyſical circumſtances of the caſe than any other. But his proceſs is there delivered in too conciſe a manner to be intelligible to a perſon not perfectly familiar with all the reſources of modern analyſis. We therefore preferred John Bernoulli's, becauſe it is elementary and rigorous.

After all, the practical artilleriſt muſt rely chiefly on the records of experiments contained in the books of practice

91 Necessity of attending to experiments.

practice at the academies, or those made in a more public manner. Even a perfect theory of the air's resistance can do him little service, unless the force of gunpowder were uniform. This is far from being the case even in the same powder. A few hours of a damp day will make a greater difference than occurs in any theory; and, in service, it is only by trial that every thing is performed. If the first shell falls very much short of the mark, a little more powder is added; and, in cannonading, the correction is made by varying the elevation.

We hope to be forgiven by the eminent mathematicians for these observations on their theories. They by no means proceed from any disrespect for their labours. We are not ignorant of the almost insuperable difficulty of the task, and we admire the ingenuity with which some of them have contrived to introduce into their analysis reasonable substitutions for those terms which would render the equations intractable. But we must still say, upon their own authority, that these are but ingenious guesses, and that experiment is the touchstone by which they mould these substitutions; and when they have found a coincidence, they have no motive to make any alteration. Now, when we have such a latitude for our measure of the air's resistance, that we may take it of any value, from one to three, it is no wonder that compensations of errors should produce a coincidence; but where is the coincidence? The theorist *supposes* the ball to set out with a certain velocity, and his theory gives a certain range; and this range agrees with observation—but how? Who knows the velocity of the ball in the experiment? This is concluded from a theory incomparably more uncertain than that of the motion in a resisting medium.

The experiments of Mr Robins and Dr Hutton show, in the most incontrovertible manner, that the resistance to a motion exceeding 1100 feet in a second, is almost *three times* greater than in the duplicate ratio to the resistance to moderate velocities. Euler's translator, in his comparison of the author's trajectories with experiment, supposes it to be *no* greater. Yet the coincidence is very great. The same may be said of the Chevalier de Borda's. Nay, the same may be said of Mr Robins's own practical rules: for he makes his F, which corresponds to our a, almost double of what these authors do, and yet his rules are confirmed by practice. Our observations are therefore well founded.

92 The theory is still of some use in practice,

But it must not be inferred from all this, that the physical theory is of no use to the practical artillerist. It plainly shows him the impropriety of giving the projectile an enormous velocity. This velocity is of no effect after 200 or 300 yards at farthest, because it is so rapidly reduced by the prodigious resistance of the air. Mr Robins has deduced several practical maxims of the greatest importance from what we already know of this subject, and which could hardly have been even conjectured without this knowledge. See GUNNERY.

93 And may be brought to greater perfection.

And it must still be acknowledged, that this branch of physical science is highly interesting to the philosopher; nor should we despair of carrying it to greater perfection. The defects arise almost entirely from our ignorance of the law of variation of the air's resistance. Experiments may be contrived much more conducive to our information here than those commonly resorted to. The oblique flights of projectiles are, as we have seen, of very complicated investigation, and ill fitted for instructing us; but numerous and well contrived experiments on the perpendicular ascents are of great simplicity, being affected by nothing but the air's resistance. To make them instructive, we think that the following plan might be pursued. Let a set of experiments be premised for ascertaining the initial velocities. Then let shells be discharged perpendicularly with great varieties of density and velocity, and let nothing be attended to but the height and the time; even a considerable deviation from the perpendicular will not affect either of these circumstances, and the effect of this circumstance can easily be computed. The height can be ascertained with sufficient precision for very valuable information by their light or smoke. It is evident that these experiments will give *direct* information of the air's retarding force; and every experiment gives us two measures, viz. the ascent and descent: and the comparison of the times of ascent and descent, combined with the observed height in one experiment made with a great initial velocity, will give us more information concerning the air's resistance than 50 ranges. If we should suppose the resistance as the square of the velocity, this comparison will give in each experiment an exact determination of the initial and final velocities, which no other method can give us. These, with experiments on the *time* of horizontal flights, with known initial velocities, will give us more instruction on this head than any thing that has yet been done; and till something of this kind is carefully done, we presume to say that the motion of bodies in a resisting medium will remain in the hands of the mathematicians as a matter of curious speculation. In the mean time, the rules which Mr Robins has delivered in his Gunnery are very simple and easy in their use, and seem to come as near the truth as any we have met with. He has not informed us upon what principles they are founded, and we are disposed to think that they are rather empirical than scientific. But we profess great deference for his abilities and penetration, and doubt not but that he had framed them by means of as scientific a discussion as his knowledge of this new and difficult subject enabled him to give it.

95 Tables calculated [on] the preceding principles.

We shall conclude this article, by giving two or three tables, computed from the principles established above, and which serve to bring into one point of view the chief circumstances of the motion in a resisting medium. Although the result of much calculation, as any person who considers the subject will readily see, they must not be considered as offering any very accurate results; or that, in comparison with one or two experiments, the differences shall not be considerable. Let any person peruse the published registers of experiments which have been made with every attention, and he will see such enormous irregularities, that all expectations of perfect agreement with them must cease. In the experiments at Woolwich in 1735, which were continued for several days, not only do the experiments of one day differ among themselves, but the mean of all the experiments of one day differs from the mean of all the experiments of another no less than one fourth of the whole. The experiments in which the greatest regularity may be expected, are those made with great elevations. When the elevation is small, the range

range is more affected by a change of velocity, and still more by any deviation from the supposed or intended direction of the shot.

The first table shows the distance in yards to which a ball projected with the velocity 1600 will go, while its velocity is reduced one tenth, and the distance at which it drops 16 feet from the line of its direction. This table is calculated by the resistance observed in Mr Robins's experiments. The first column is the weight of the ball in pounds. The second column remains the same whatever be the initial velocity; but the third column depends on the velocity. It is here given for the velocity which is very usual in military service, and its use is to assist us in directing the gun to the mark.—If the mark at which a ball of 24 pounds is directed is 474 yards distant, the axis of the piece must be pointed 16 feet higher than the mark. These deflections from the line of direction are nearly as the squares of the distances.

I.	II.	III.
2	92	420
4	121	428
9	159	456
18	200	470
32	272	479

The next table contains the ranges in yards of a 24 pound shot, projected at an elevation of 45°, with the different velocities in feet per second, expressed in the first column. The second column contains the distances to which the ball would go in vacuo in a horizontal plane; and the third contains the distances to which it will go through the air. The fourth column is added, to show the height to which it rises in the air; and the fifth shows the ranges corrected for the diminution of the air's density as the bullet ascends, and may therefore be called the *corrected range*.

I.	II.	III.	IV.	V.
200	416	349	106	360
400	1664	1121	338	1150
600	3740	1812	606	1859
800	6649	2373	866	2435
1000	10390	2845	1138	2919
1200	14961	3259	1378	3343
1400	20364	3640	1606	3734
1600	26597	3950	1814	4050
1800	33663	4235	1992	4345
2000	41559	4494	2168	4610
2200	50286	4720	2348	4842
2400	59846	4917	2460	5044
2600		5106	2630	5238
2800		5293	2762	5430
3000		5455	2862	5596
3200				5732

95 Use of the table.

The initial velocities can never be pushed as far as we have calculated for in this table; but we mean it for a table of more extensive use than appears at first sight. Recollect, that while the proportion of the velocity at the vertex to the terminal velocity remains the same, the curves will be similar: therefore, if the initial velocities are as the square-roots of the diameters of the balls, they will describe similar curves, and the ranges will be as the diameters of the balls.

Therefore, to have the range of a 12 pound shot, if projected at an elevation of 45, with the velocity 1500; suppose the diameter of the 12 pounder to be d, and that of the 24 pounder D; and let the velocities be v and V: Then say, $\sqrt{d}:\sqrt{D}=1500$, to a fourth proportional V. If the 24 pounder be projected with the velocity V, it will describe a curve similar to that described by the 12 pounder, having the initial velocity 1500. Therefore find (by interpolation) the range of the 24 pounder, having the initial velocity V. Call this R. Then $D:d=R:r$, the range of the 12 pounder which was wanted, and which is nearly 3380 yards.

We see by this table the immense difference between the motions through the air and in a void. We see that the ranges through the air, instead of increasing in the duplicate ratio of the initial velocities, really increase slower than those velocities in all cases of military service; and in the most usual cases, viz. from 800 to 1600, they increase nearly as the square-roots of the velocities.

A set of similar tables, made for different elevations, would almost complete what can be done by theory, and would be much more expeditious in their use than Mr Euler's Trajectories, computed with great labour by his English translator.

The same table may also serve for computing the ranges of bomb-shells. We have only to find what must be the initial velocity of the 24 pound shot which corresponds to the proposed velocity of the shell. This must be deduced from the diameter and weight of the shell, by making the velocity of the 24 pounder such, that the ratio of its weight to the resistance may be the same as in the shell.

Plate CCCCXVIII.

96 Relation of the different quantities in it.

That the reader may see with one glance the relation of those different quantities, we have given this table, expressed in a figure (fig. 10). The abscissa, or axis DA, is the scale of the initial velocities in feet per second, measured on a scale of 400 equal parts in an inch. The ordinates to the curve ACG express the yards of the range on a scale containing 800 yards in an inch. The ordinates to the curve A x y express (by the same scale) the height to which the ball rises in the air.

The ordinate BC (drawn through the point of the abscissa which corresponds to the initial velocity 2000) is divided in the points 4, 9, 12, 18, 24, 32, 42, in the ratio of the diameters of cannon-shot of different weights; and the same ordinate is produced on the other side of the axis, till BO be equal to BA; and then BO is divided in the subduplicate ratio of the same diameters. Lines are drawn from the point A, and from any point D of the abscissa, to these divisions.

We see distinctly by this figure how the effect of the initial velocity gradually diminishes, and that in very great velocities the range is very little increased by its augmentation. The dotted curve APQR, shows what the ranges in vacuo would be.

By this figure may the problems be solved. Thus, to find the range of the 12 pounder, with the initial velocity

velocity 1500. Set off 1500 from B to F; draw FH parallel to the axis, meeting the line 12 A in H; draw the ordinate HK; draw KL parallel to the axis, meeting 24 B in L; draw the ordinate LM, cutting 12 B in N. MN is the range required.

If curves, such as ACG, were laid down in the same manner for other elevations, all the problems might be solved with great dispatch, and with much more accuracy than the theory by which the curves are drawn can pretend to.

PROJECTION OF THE SPHERE.

Stereographic Projection of the Sphere.

THE PROJECTION of the SPHERE is a perspective representation of the circles on the surface of the sphere; and is variously denominated according to the different positions of the eye and plane of projection.

There are three principal kinds of projection; the *stereographic*, the *orthographic*, and *gnomonic*. In the stereographic projection the eye is supposed to be placed on the surface of the sphere; in the orthographic it is supposed to be at an infinite distance; and in the gnomonic projection the eye is placed at the centre of the sphere. Other kinds of projection are, the *globular*, *Mercator's*, *scenographic*, &c. for which see the articles GEOGRAPHY, NAVIGATION, PERSPECTIVE, &c.

DEFINITIONS.

1. The plane upon which the circles of the sphere are described, is called the *plane of projection*, or the *primitive circle*. The pole of this circle is the *pole of projection*, and the place of the eye is the *projecting point*.

2. The *line of measures* of any circle of the sphere is that diameter of the primitive, produced indefinitely, which passes through the centre of the projected circle.

AXIOM.

The projection, or representation of any point, is where the straight line drawn from it to the projecting point intersects the plane of projection.

SECTION I.

Of the Stereographic Projection of the Sphere.

IN the stereographic projection of the sphere, the eye is placed on the surface of the sphere in the pole of the great circle upon which the sphere is to be projected. The projection of the hemisphere opposite to the eye falls within the primitive, to which this projection is generally limited: it, however, may be extended to the other hemisphere, or that wherein the eye is placed, the projection of which falls without the primitive.

As all circles in this projection are projected either into circles or straight lines, which are easily described, it is therefore more generally understood, and by many preferred to the other projections.

PROPOSITION I. THEOREM I.

Every great circle which passes through the projecting point is projected into a straight line passing through the centre of the primitive; and every arch of it, reckoned from the other pole of the primitive, is projected into its semitangent.

Stereographic Projection of the Sphere. Plate CCCCXIX.

Let ABCD (fig. 1.) be a great circle passing thro' A, C, the poles of the primitive, and intersecting it in the line of common section BED, E being the centre of the sphere. From A, the projecting point, let there be drawn straight lines AP, AM, AN, AQ, to any number of points P, M, N, Q, in the circle ABCD: these lines will intersect BED, which is in the same plane with them. Let them meet it in the points p, m, n, q; then p, m, n, q, are the projections of P, M, N, Q: hence the whole circle ABCD is projected into the straight line BED, passing through the centre of the primitive.

Again, because the pole C is projected into E, and the point M into m; therefore the arch CM is projected into the straight line Em, which is the semitangent of the arch CM to the radius AE. In like manner, the arch CP is projected into its semitangent Ep, &c.

COROLLARIES.

1. Each of the quadrants contiguous to the projecting point is projected into an indefinite straight line, and each of those that are remote into a radius of the primitive.

2. Every small circle which passes through the projecting point is projected into that straight line which is its common section with the primitive.

3. Every straight line in the plane of the primitive, and produced indefinitely, is the projection of some circle on the sphere passing through the projecting point.

4. The projection of any point in the surface of the sphere, is distant from the centre of the primitive, by the semitangent of the distance of that point from the pole opposite to the projecting point.

PROPOSITION II. THEOREM II.

Every circle on the sphere which does not pass through the projecting point is projected into a circle.

If the given circle be parallel to the primitive, then a straight line drawn from the projecting point to any point in the circumference, and made to revolve about the circle, will describe the surface of a cone; which being cut by the plane of projection parallel to the base, the section will be a circle. See CONIC-SECTIONS.

But if the circle MN (fig. 2.) be not parallel to the primitive circle BD, let the great circle ABCD, passing through the projecting point, cut it at right angles in the diameter MN, and the primitive in the diameter BD. Through M, in the plane of the great circle, let MF be drawn parallel to BD; let AM, AN be joined, and

Stereographic Projection of the Sphere.

and meet BD in *m. n*. Then, becauſe AB, AD are quadrants, and BD, MF parallel, the arch AM is equal to AF, and the angle AMF or A*mn* is equal to ANM. Hence the conic ſurface deſcribed by the revolution of AM about the circle MN is cut by the primitive in a ſubcontrary poſition; therefore the ſection is in this caſe likewiſe a circle.

Corollaries.

1. The centres and poles of all circles parallel to the primitive have their projections in its centre.

2. The centre and poles of every circle inclined to the primitive have their projections in the line of meaſures.

3. All projected great circles cut the primitive in two points diametrically oppoſite; and every circle in the plane of projection, which paſſes through the extremities of a diameter of the primitive, or through the projections of two points that are diametrically oppoſite on the ſphere, is the projection of ſome great circle.

4. A tangent to any circle of the ſphere, which does not paſs through the projecting point, is projected into a tangent to that circle's projection; alſo, the circular projections of tangent circles touch one another.

5. The extremities of the diameter, on the line of meaſures of any projected circle, are diſtant from the centre of the primitive by the ſemitangents of the leaſt and greateſt diſtances of the circle on the ſphere, from the pole oppoſite to the projecting point.

6. The extremities of the diameter, on the line of meaſures of any projected great circle, are diſtant from the centre of the primitive by the tangent and cotangent of half the great circle's inclination to the primitive.

7. The radius of any projected circle is equal to half the ſum, or half the difference of the ſemitangents of the leaſt and greateſt diſtances of the circle from the pole oppoſite to the projecting point, according as that pole is within or without the given circle.

Proposition III. Theorem III.

An angle formed by two tangents at the ſame point in the ſurface of the ſphere, is equal to the angle formed by their projections.

Plate CCCCXIX. Let FGI and GH (fig. 3.) be the two tangents, and A the projecting point; let the plane AGF cut the ſphere in the circle AGL, and the primitive in the line BML. Alſo, let MN be the line of common ſection of the plane AGH with the primitive: then the angle FGH=LMN. If the plane FGH be parallel to the primitive BLD, the propoſition is manifeſt. If not, through any point K in AG produced, let the plane FKH, parallel to the primitive, be extended to meet FGH in the line FH. Then, becauſe the plane AGF meets the two parallel planes BLD, FKH, the lines of common ſection LM, FK are parallel; therefore the angle AML=AKF. But ſince A is the pole of BLD, the chords, and conſequently the arches AB AL, are equal, and the arch ABG is the ſum of the arches AL, BG; hence the angle AML is equal to an angle at the circumference ſtanding upon AG, and therefore equal to AGI or FGK; conſequently the angle FGK=FKG, and the ſide FG=FK. In like manner HG=HK: hence the triangles GHF, KHF are equal, and the angle FGH=FKH=LMN.

Corollaries.

1. An angle contained by any two circles of the ſphere is equal to the angle formed by their projections. For the tangents to theſe circles on the ſphere are projected into ſtraight lines, which either coincide with, or are tangents to, their projections on the primitive.

2. An angle contained by any two circles of the ſphere is equal to the angle formed by the radii of their projections at the point of interſection.

Proposition IV. Theorem IV.

The centre of a projected great circle is diſtant from the centre of the primitive; the tangent of the inclination of the great circle to the primitive, and its radius, is the ſecant of its inclination.

Let MNG (fig. 4.) be the projection of a great circle, meeting the primitive in the extremities of the diameter MN, and let the diameter BD, perpendicular to MN, meet the projection in F, G. Biſect FG in H, and join NH. Then, becauſe any angle contained by two circles of the ſphere is equal to the angle formed by the radii of their projections at the point of interſection; therefore the angle contained by the propoſed great circle and the primitive is equal to the angle ENH, of which EH is the tangent, and NH the ſecant, to the radius of the primitive.

Corollaries.

1. All circles which paſs through the points M, N are the projections of great circles, and have their centres in the line BG; and all circles which paſs through the points F, G are the projections of great circles, and have their centres in the line HI, perpendicular to BG.

2. If NF, NH be continued to meet the primitive in L, F; then BL is the meaſure of the great circle's inclination to the primitive; and MT=2BL.

Proposition V. Theorem V.

The centre of projection of a leſs circle perpendicular to the primitive, is diſtant from the centre of the primitive, the ſecant of the diſtance of the leſs circle from its neareſt pole; and the radius of projection is the tangent of that diſtance.

Let MN (fig. 5.) be the given leſs circle perpendicular to the primitive, and A the projecting point. Draw AM, AN to meet the diameter BD produced in G and H; then GH is the projected diameter of the leſs circle: biſect GH in C, and C will be its centre; join NE, NC. Then becauſe AE, NI are parallel, the angle INE=NEA; but NEA=2NMA =2NHG=NCG: hence ENC=INE+INC=NCG +INC= a right angle; and therefore NC is a tangent to the primitive at N; but the arch ND is the diſtance of the leſs circle from its neareſt pole D: hence NC is the tangent, and EC the ſecant of the diſtance of the leſs circle from its pole to the radius of the primitive.

PROPOSITION VI. THEOREM VI.

The projection of the poles of any circle, inclined to the primitive, are, in the line of measures, distant from the centre of the primitive, the tangent, and cotangent, of half its inclination.

Plate CCCCXIX.

Let MN (fig. 6.) be a great circle perpendicular to the primitive ABCD, and A the projecting point; then P, *p* are the poles of MN, and of all its parallels *m n*, &c. Let AP, A*p* meet the diameter BD in F*f*, which will therefore be the projected poles of MN and its parallels. The angle BEM is the inclination of the circle MEN, and its parallels, to the primitive: and because BC and MP are quadrants, and MC common to both; therefore PC=BM: and hence PEC is also the inclination of MN and its parallels. Now EF is the tangent of EAF, or of half the angle PEC the inclination; and E*f* is the tangent of the angle EA*f*; but EA*f* is the complement of EAF, hence E*f* is the cotangent of half the inclination.

COROLLARIES.

1. The projection of that pole which is nearest to the projecting point is without the primitive, and the projection of the other within.

2. The projected centre of any circle is always between the projection of its nearest pole and the centre of the primitive; and the projected centres of all circles are contained between their projected poles.

PROPOSITION VII. THEOREM VII.

Equal arches of any two great circles of the sphere will be intercepted between two other circles drawn on the sphere through the remote poles of those great circles.

Let AGB, CFD (fig. 7.) be two great circles of the sphere, whose remote poles are E, P; through which draw the great circle PBEC, and less circle PGE, intersecting the great circles AGB, CFD, in the points B, G, and D, F; then the arch BG is equal to the arch DF.

Because E is the pole of the circle AGB, and P the pole of CFD, therefore the arches EB, PD are equal; and since BD is common to both, hence the arch ED is equal to the arch PB. For the same reason, the arches EF, PG are equal; but the angle DEF is equal to the angle BPG: hence these triangles are equal, and therefore the arch DF is equal to the arch BG.

PROPOSITION VIII. THEOREM VIII.

If from either pole of a projected great circle, two straight lines be drawn to meet the primitive and the projection, they will intercept similar arches of these circles.

On the plane of projection AGB (fig. 7.) let the great circle CFD be projected into *c f d*, and its pole P into *p*; through *p* draw the straight lines *p d*, *p f*, then are the arches GB, *f d* similar.

Since *p d* lies both in the plane AGB and APBE, it is in their common section, and the point B is also in their common section; therefore *p d* passes through the point B. In like manner it may be shown that the line *p f* passes through G. Now the points D, F are projected into *d*, *f*: hence the arches FD, *f d* are similar; but GB is equal to FD, therefore the intercepted arch of the primitive GB is similar to the projected arch *f d*.

COROLLARY.

Hence, if from the angular point of a projected spherical angle two straight lines be drawn through the projected poles of the containing sides, the intercepted arch of the primitive will be the measure of the spherical angle.

PROPOSITION IX. PROBLEM I.

To describe the projection of a great circle through two given points in the plane of the primitive.

Let P and B be given points, and C the centre of the primitive.

1. When one point P (fig. 8.) is the centre of the primitive, a diameter drawn through the given points will be the great circle required.

2. When one point P (fig. 9.) is in the circumference of the primitive. Through P draw the diameter PD; and an oblique circle described through the three points P, B, D, will be the projection of the required great circle.

3. When the given points are neither in the centre nor circumference of the primitive. Through either of the given points P (fig. 10) draw the diameter ED, and at right angles thereto draw the diameter FG. From F through P draw the straight line FPH, meeting the circumference in H: draw the diameter HI, and draw the straight line FIK, meeting ED produced in D; then an arch, terminated by the circumference, being described through the three points P, B, K, will be the great circle.

PROPOSITION X. PROBLEM II.

To describe the representation of a great circle about any given point as a pole.

Let P be the given pole, and C the centre of the primitive.

1. When P (fig. 8.) is in the centre of the primitive, then the primitive will be the great circle required.

2. When the pole P (fig. 11.) is in the circumference of the primitive. Through P draw the diameter PE, and the diameter AB drawn at right angles to PE will be the projected great circle required.

3. When the given pole is neither in the centre nor circumference of the primitive. Through the pole P (fig. 12.) draw the diameter AB, and draw the diameter DE perpendicular to AB; through E and P draw the straight line EPF, meeting the circumference in F. Make FG equal to FD; through E and G draw the straight line EGH, meeting the diameter AB produced if necessary in H; then from the centre H, with the radius HE, describe the oblique circle DIE, and it will be the projection of the great circle required.

Plate CCCCXX.

Or, make DK equal to FA; join EK, which intersects the diameter AB in I; then through the three points D, I, E, describe the oblique circle DIE.

PROPOSITION XI. PROBLEM III.

To find the poles of a great circle.

1. When the given great circle is the primitive, its centre is the pole.

Plate CCCCXIX. Plate CCCCXX.

2. To find the pole of the right circle ACB (fig. 11.) Draw the diameter PE perpendicular to the given circle AB; and its extremities P, E are the poles of the circle ACB.

3. To find the pole of the oblique circle DEF (fig. 13.) Join DF, and perpendicular thereto draw the diameter AB, cutting the given oblique circle DEF in E. Draw the ftraight line FEG, meeting the circumference in G. Make GI, GH, each equal to AD; then FI being joined, cuts the diameter AB in P, the lower pole; through F and H draw the ftraight line FH*p*, meeting the diameter AB produced in *p*, which will be the oppofite or exterior pole.

Proposition XII. Problem IV.

To defcribe a lefs circle about any given point as a pole, and at any given diftance from that pole.

1. When the pole of the lefs circle is in the centre of the primitive; then from the centre of the primitive, with the femitangent of the diftance of the given circle from its pole, defcribe a circle, and it will be the projection of the lefs circle required.

2. If the given pole is in the circumference of the primitive, from C (fig. 14.), the centre of the primitive, fet off CE the fecant of the diftance of the lefs circle from its pole P; then from the centre E, with the tangent of the given diftance, defcribe a circle, and it will be the lefs circle required. Or, make PG, PF each equal to the chord of the diftance of the lefs circle from its pole. Through B, G, draw the ftraight line BGD meeting CP produced in D: bifect GD in H, and draw HE perpendicular to GD; and meeting PD in E, then E is the centre of the lefs circle.

3. When the given pole is neither in the centre nor circumference of the primitive. Through P (fig. 15.), the given pole, and C the centre of the primitive, draw the diameter AB, and draw the diameter DE perpendicular to AB; join EP, and produce it to meet the primitive in *p*; make *p*F, *p*G, each equal to the chord of the diftance of the lefs circle from its pole; join EF which interfects the diameter AB in H; from E through G draw the ftraight line EGI, meeting the diameter AB produced in I; bifect HI in K: Then a circle defcribed from the centre K, at the diftance KH or KI, will be the projection of the lefs circle.

Proposition XIII. Problem V.

To find the poles of a given lefs circle.

The poles of a lefs circle are alfo thofe of its parallel great circle. If therefore the parallel great circle be given, then its poles being found by Prob. III. will be thofe of the lefs circle. But if the parallel great circle be not given, let HMIN (fig. 15.) be the given lefs circle. Through its centre, and C the centre of the primitive, draw the line of meafures IAHB; and draw the diameter DE perpendicular to it, alfo draw the ftraight line EHF meeting the primitive in F; make F*p* equal to the chord of the diftance of the lefs circle from its pole; join E*p*, and its interfection P with the diameter AB is the interior pole. Draw the diameter *p*CL through E and L, draw EL*q* meeting the diameter AB produced in *q*; then *q* is the external pole. Or thus: Join EI interfecting the primitive in G; join alfo EH, and produce it to meet the primitive in F, bifect the arch GF in *p*; from E to *p* draw the ftraight line EP*p*, and P is the pole of the given lefs circle.

Proposition XIV. Problem VI.

To meafure any arch of a great circle.

1. Arches of the primitive are meafured on the line of chords.

2. Right circles are meafured on the line of femitangents, beginning at the centre of the primitive. Thus, the meafure of the portion AC (fig. 16.) of the right circle DE, is found by applying it to the line of femitangents. The meafure of the arch DB is found by fubtracting that of BC from 90°: the meafure of the arch AF, lying partly on each fide of the centre, is obtained by adding the meafures of AC and CF. Laftly, To meafure the part AB, which is neither terminated at the centre or circumference of the primitive, apply CA to the line of femitangents; then CB, and the difference between the meafures of thefe arches, will be that of AB.

Or thus, Draw the diameter GH perpendicular to DE; then from either extremity, as D, of this diameter, draw lines through the extremities of the arch intended to be meafured; and the intercepted portion of the primitive applied to the line of chords will give the meafure of the required arch. Thus IK applied to the line of chords will give the meafure of AB.

3. To meafure an arch of an oblique circle: draw lines from its pole through the extremities of the arch to meet the primitive, then the intercepted portion of the primitive applied to the line of chords will give the meafure of the arch of the oblique circle. Thus, let AB (fig. 17.), be an arch of an oblique circle to be meafured, and P its pole; from P draw the lines PAD, PBE meeting the primitive in B and E; then the arch DE applied to the line of chords will give the meafure of the arch of the oblique circle AB.

Proposition XV. Problem VII.

To meafure any arch of a lefs circle.

Let DEG (fig. 18.) be the given lefs circle, and DE the arch to be meafured: find its internal pole P; and defcribe the circle AFI parallel to the primitive, and whofe diftance from the projecting point may be equal to the diftance of the given lefs circle from its pole P: then join PD, PE, which produce to meet the parallel circle in A and F. Now AF applied to a line of chords will give the meafure of the arch DE of the given lefs circle.

Proposition XVI. Problem VIII.

To meafure any fpherical angle.

1. If the angle is at the centre of the primitive, it is meafured as a plane angle.

2. When the angular point is in the circumference of the primitive; let A (fig. 19.) be the angular point, and ABE an oblique circle inclined to the primitive. Through P, the pole of ABE, draw the line AP*p* meeting the circumference in *p*: then the arch E*p* is the meafure of the angle BAD, and the arch AF*p* is the meafure of its fupplement BAF: alfo *p*F is the meafure of the angle BAC, and *p*ED that of its fupplement.

3. If

Stereographic Projection of the Sphere.

Plate CCCCXX.

3. If the angular point is neither at the centre nor circumference of the primitive. Let A (fig. 20.) be the angular point, and DAH, or GAF the angle to be meafured, P the pole of the oblique circle DAF, and *p* the pole of GAH: then from A, through the points P *p*, draw the ftraight lines APM, A *p* N, and the arch MN will be the meafure of the angle DAH; and the fupplement of MN will be the meafure of the angle HAF or DAG.

Proposition XVII. Problem IX.

To draw a great circle perpendicular to a projected great circle, and through a point given in it.

Find the pole of the given circle, then a great circle defcribed through that pole and the given point will be perpendicular to the given circle. Hence if the given circle be the primitive, then a diameter drawn through the given point will be the required perpendicular. If the given circle is a right one, draw a diameter at right angles to it; then through the extremities of this diameter and the given point defcribe an oblique circle, and it will be perpendicular to that given. If the given circle is inclined to the primitive, let it be reprefented by BAD (fig. 21.), whofe pole is P, and let A be the point through which the perpendicular is to be drawn: then, by Prob. I. defcribe a great circle through the points P and A, and it will be perpendicular to the oblique circle BAD.

Proposition XVIII. Problem X.

Through a point in a projected great circle, to defcribe another great circle to make a given angle with the former, provided the meafure of the given angle is not lefs than the diftance between the given point and circle.

Let the given circle be the primitive, and let A (fig. 19.) be the angular point. Draw the diameters AE, DF perpendicular to each other; and make the angle CAG equal to that given, or make CG equal to the tangent of the given angle; then from the centre G, with the diftance GC, defcribe the oblique circle ABE, and it will make with the primitive an angle equal to that given.

If the given circle be a right one, let it be APB (fig. 22.) and let P be the given point. Draw the diameter GH perpendicular to AB; join GP, and produce it to *a*; make H *b* equal to twice A *a*; and G *b* being joined interfects AB in C. Draw CD perpendicular to AB, and equal to the cotangent of the given angle to the radius PC; or make the angle CPD equal to the complement of that given: then from the centre D, with the radius DP, defcribe the great circle FPE, and the angle APF, or BPE, will be equal to that given.

If APB (fig. 23.) is an oblique circle. From the angular point P, draw the lines PG, PC through the centres of the primitive and given oblique circle. Through C, the centre of APB, draw GCD at right angles to PG; make the angle GPD equal to that given; and from the centre D, with the radius DP, defcribe the oblique circle FPE, and the angle APF, or BPE, will be equal to that propofed.

Proposition XIX. Problem XI.

Any great circle cutting the primitive being given, to defcribe another great circle which fhall cut the given one in a propofed angle, and have a given arch intercepted between the primitive and given circles.

If the given circle be a right one, let it be reprefented by APC (fig. 24.); and at right angles thereto draw the diameter BPM; make the angle BPF equal to the complement of the given angle, and PF equal to the tangent of the given arch; and from the centre of the primitive with the fecant of the fame arch defcribe the arch G *g*. Through F draw FG parallel to AC, meeting G *g* in G; then from the centre G, with the tangent PF, defcribe an arch *n o*, cutting APC in I, and join GI. Through G, and the centre P, draw the diameter HK; draw PL perpendicular to HK, and IL perpendicular to GI, meeting PL in L; then L will be the centre of the circle HIK, which is that required.

But if the given great circle be inclined to the primitive, let it be ADB (fig. 25.), and E its centre: make the angle BDF equal to the complement of that given, and DF equal to the tangent of the given arch, as before. From P, the centre of the primitive, with the fecant of the fame arch, defcribe the arch G *g*, and from E, the centre of the oblique circle, with the extent EF, defcribe an arch interfecting G *g* in G. Now G being determined, the remaining part of the operation is performed as before.

When the given arch exceeds 90°, the tangent and fecant of its fupplement are to be applied on the line DF the contrary way, or towards the right; the former conftruction being reckoned to the left.

Proposition XX. Problem XII.

Any great circle in the plane of projection being given to defcribe another great circle, which fhall make given angles with the primitive and given circles.

Let ADC (fig. 26.) be the given circle, and Q its pole. About P, the pole of the primitive, defcribe an arch *m n*, at the diftance of as many degrees as are in the angle which the required circle is to make with the primitive. About Q the pole of the circle ADC, and at a diftance equal to the meafure of the angle which the required circle is to make with the given circle ADC, defcribe an arch *o n*, cutting *m n* in *n*. Then about *n* as a pole, defcribe the great circle EDF, cutting the primitive and given circle in E and D, and it will be the great circle required.

Scholium.

It will hence be an eafy matter to conftruct all the various fpherical triangles. The reader is, however, referred to the article *Spherical* TRIGONOMETRY, for the method of conftructing them agreeable to this projection; and alfo for the application to the refolution of problems of the fphere. For the method of projecting the fphere upon the plane of the meridian, and of the horizon, according to the ftereographic projection, fee the article GEOGRAPHY.

SECTION II.

Of the Orthographic Projection of the Sphere.

THE orthographic projection of the fphere, is that in which the eye is placed in the axis of the plane of projection

gra- ro- n of phere.

jection, at an infinite distance with respect to the diameter of the sphere; so that at the sphere all the visual rays are assumed parallel, and therefore perpendicular to the plane of projection.

Hence the orthographic projection of any point is where a perpendicular from that point meets the plane of projection: and the orthographic representation of any object is the figure formed by perpendiculars drawn from every point of the object to the plane of projection.

This method of projection is used in the geometrical delineation of eclipses, occultations, and transits. It is also particularly useful in various other projections, such as the analemma. See GEOGRAPHY, &c.

PROPOSITION I. THEOREM I.

Every straight line is projected into a straight line. If the given line be parallel to the plane of projection, it is projected into an equal straight line; but if it is inclined to the primitive, then the given straight line will be to its projection in the ratio of the radius to the cosine of inclination.

late CXXI.

Let AB (fig. 27.) be the plane of projection, and let CD be a straight line parallel thereto: from the extremities C, D of the straight line CD, draw the lines CE, DF perpendicular to AB; then by 3. of XI. of Eucl. the intersection EF, of the plane CEFD, with the plane of projection, is a straight line: and because the straight lines CD, EF are parallel, and also CE, DF; therefore, by 34. of I. of Eucl. the opposite sides are equal; hence the straight line CD, and its projection EF, are equal. Again, let GH be the proposed straight line, inclined to the primitive; then the lines GE, HF being drawn perpendicular to AB, the intercepted portion EF will be the projection of GH. Through G draw GI parallel to AB, and the angle IGH will be equal to the inclination of the given line to the plane of projection. Now GH being the radius, GI, or its equal EF, will be the cosine of IGH; hence the given line GH is to its projection EF as radius to the cosine of inclination.

COROLLARIES.

1. A straight line perpendicular to the plane of projection is projected into a point.

2. Every straight line in a plane parallel to the primitive is projected into an equal and parallel straight line.

3. A plane angle parallel to the primitive is projected into an equal angle.

4. Any plane rectilineal figure parallel to the primitive is projected into an equal and similar figure.

5. The area of any rectilineal figure is to the area of its projection as radius to the cosine of its inclination.

PROPOSITION II. THEOREM II.

Every great circle, perpendicular to the primitive, is projected into a diameter of the primitive; and every arch of it, reckoned from the pole of the primitive, is projected into its sine.

Let BFD (fig. 28.) be the primitive, and ABCD a great circle perpendicular to it, passing through its poles A, C; then the diameter BED, which is their line of common section, will be the projection of the circle ABCD. For if from any point, as G, in the circle ABC, a perpendicular GH fall upon BD, it will also be perpendicular to the plane of the primitive: therefore H is the projection of G. Hence the whole circle is projected into BD, and any arch AG into EH equal to GI its sine.

Orthographic Projection of the Sphere.

COROLLARIES.

1. Every arch of a great circle, reckoned from its intersection with the primitive, is projected into its versed sine.

2. Every less circle perpendicular to the primitive is projected into its line of common section with the primitive, which is also its own diameter; and every arch of the semicircle above the primitive, reckoned from the middle point, is projected into its sine.

3. Every diameter of the primitive is the projection of a great circle; and every chord the projection of a less circle.

4. A spherical angle at the pole of the primitive is projected into an equal angle.

PROPOSITION III. THEOREM III.

A circle parallel to the primitive is projected into a circle equal to itself, and concentric with the primitive.

Let the less circle FIG (fig. 29.) be parallel to the plane of the primitive BND. The straight line HE, which joins their centres, is perpendicular to the primitive; therefore E is the projection of H. Let any radii HI and IN perpendicular to the primitive be drawn. Then IN, HE being parallel, are in the same plane; therefore IH, NE, the lines of common section of the plane IE, with two parallel planes, are parallel; and the figure IHEN is a parallelogram. Hence NE = IH, and consequently FIG is projected into an equal circle KNL, whose centre is E.

COROLLARY.

The radius of the projection is the cosine of the distance of the parallel circle from the primitive, or the sine of its distance from the pole of the primitive.

PROPOSITION IV. THEOREM IV.

An inclined circle is projected into an ellipse, whose transverse axis is the diameter of the circle.

1. Let ELF (fig. 30.) be a great circle inclined to the primitive EBF, and EF their line of common section. From the centre C, and any other point K, in EF, let the perpendiculars CB, KI be drawn in the plane of the primitive, and CL, KN, in the plane of the great circle, meeting the circumference in L, N. Let LG, ND be perpendicular to CB, KI; then G, D are the projections of L, N. And because the triangles LCG, NKD are equiangular, $CL^2 : CG : : NK^2 : DK^2$; or $EC^2 : CG^2 : : EKF : DK^2$: therefore the points G, D are in the curve of an ellipse, of which EF is the transverse axis, and CG the semiconjugate axis.

COROLLARIES.

1. In a projected great circle, the semiconjugate axis is the cosine of the inclination of the great circle to the primitive.

Orthographic Projection of the Sphere.

Plate CCCCXXI.

2. Perpendiculars to the tranfverfe axis intercept correfponding arches of the projection and the primitive.

3. The eccentricity of the projection is the fine of the inclination of the great circle to the primitive.

Cafe 2. Let AQB (fig. 31.) be a lefs circle, inclined to the primitive, and let the great circle LBM, perpendicular to both, interfect them in the lines AB, LM. From the centre O, and any other point N in the diameter AB, let the perpendiculars TOP, NQ, be drawn in the plane of the lefs circle, to meet its circumference in T, P, Q. Alfo, from the points A, N, O, B, let AG, NI, OC, BH, be drawn perpendicular to LM; and from P, Q, T, draw PE, QD, TF perpendicular to the primitive; then G, I, C, H, E, D, F, are the projections of thefe points. Becaufe OP is perpendicular to LBM, and OC, PE, being perpendicular to the primitive, are in the fame plane, the plane COPE is perpendicular to LBM. But the primitive is perpendicular to LBM; therefore the common fection EC is perpendicular to LBM, and to LM. Hence CP is a parallelogram, and EC = OP. In like manner, FC, DI, are proved perpendicular to LM, and equal to OT, NQ. Thus, ECF is a ftraight line, and equal to the diameter PT. Let QR, DK be parallel to AB, LM; then RO = NQ = DI = KC, and PR × RT = EK × KF. But AO : CG : : NO : CI; therefore $AO^2 : CG^2 :: QR^2 : DK^2$ and $EC^2 : CG^2 :: EKF : DK^2$.

Corollaries.

1. The tranfverfe axis is to the conjugate as radius to the cofine of the circle's inclination to the primitive.

2. Half the tranfverfe axis is the cofine of half the fum of the greateft and leaft diftances of the lefs circle from the primitive.

3. The extremities of the conjugate axis are in the line of meafures, diftant from the centre of the primitive by the cofines of the greateft and leaft diftances of the lefs circle from the primitive.

4. If from the extremities of the conjugate axis of any elliptical projection perpendiculars be drawn (in the fame direction if the circle do not interfect the primitive, but if otherwife in oppofite directions), they will interfect an arch of the primitive, whofe chord is equal to the diameter of the circle.

Proposition V. Theorem V.

The projected poles of an inclined circle are in its line of meafures diftant from the centre of the primitive the fine of the inclination of the circle to the primitive.

Let ABCD (fig 32.) be a great circle, perpendicular both to the primitive and the inclined circle, and interfecting them in the diameters AC, MN. Then ABCD paffes through the poles of the inclined circle; let thefe be P, Q; and let P*p*, Q*q*, be perpendicular to AC; *p*, *q* are the projected poles; and it is evident that *p* O = fine of BP, or MA, the inclination.

Corollaries.

1. The centre of the primitive, the centre of the projection, the projected poles, and the extremities of the conjugate axis, are all in one and the fame ftraight line.

2. The diftance of the centre of projection from the centre of the primitive, is to the cofine of the diftance of the circle from its own pole, as the fine of the circle's inclination to the primitive is to the radius.

Proposition VI. Problem I.

To defcribe the projection of a circle perpendicular to the primitive, and whofe diftance from its pole is equal to a given quantity.

Let PA*p*B (fig. 33.) be the primitive circle, and P, *p* the poles of the right circle to be projected. Then if the circle to be projected is a great circle, draw the diameter AB at right angles to the axis P*p*, and it will be that required. But if the required projection is that of a lefs circle, make PE, PF each equal to the chord of the diftance of the lefs circle from its pole; join EF, and it will be the projection of the lefs circle required.

Proposition VII. Problem II.

Through a given point in the plane of the primitive to defcribe the projection of a great circle, having a given inclination to the primitive.

1. When the given inclination is equal to a right angle, a ftraight line drawn through the centre of the primitive and the given point will be the projection required.

2. When the given inclination is lefs than a right angle, and the given point in the circumference of the primitive. Let R (fig. 34.) be a point given in the circumference of the primitive, through which it is required to draw the projection of a great circle, inclined to the primitive in an angle meafured by the arch QP of the primitive.

Through the given point R draw the diameter RCS, and draw GC*g* at right angles to it. Make the arch GV of the primitive equal to QP, and draw VA at right angles to GC; and in G*g*, towards the oppofite parts of C, take CB equal to AC; then, with the greater axis RS, and lefs axis AB, defcribe an ellipfe, and it will be the projection of the oblique circle required.

3. When the diftance of the given point from the primitive is equal to the cofine of the given inclination.

Every thing remaining as in the preceding cafe; let A be the given point, and AC the cofine of an arch GV, equal to the given arch QP; then drawing the diameter RCS at right angles to ACB, the ellipfe defcribed with the given axis RS, AB will be the projection of the inclined circle.

4. When the diftance of the given point from the centre of the primitive is lefs than the femidiameter of the primitive, but greater than the cofine of the given inclination.

Let D be the given point, through which draw the diameter IC*i*; and at the point D draw DL perpendicular to DC meeting the primitive in L; alfo draw LK, making with LD the angle DLK equal to the complement of the given inclination. Let LK meet DC in K; then will DK be lefs than DC. On DC as a diameter defcribe a circle, and make DH equal to DK; through H draw a diameter of the primitive RCS, and defcribe an ellipfe through the points R, D, S, and it will be the projection of the inclined circle.

Walker's the Sphere p. 159.

Orthographic Projection of the Sphere.

PROPOSITION VIII. PROBLEM III.

Through two given points in the plane of the primitive to describe the projection of a great circle.

1. If the two given points and the centre of the primitive be in the same straight line, then a diameter of the primitive being drawn through these points will be the projection of the great circle required.

2. When the two given points are not in the same straight line with the centre of the primitive; and one of them is in the circumference of the primitive.

Plate CCCCXXI.

Let D, R, (fig. 34.) be the two given points, of which R is in the circumference of the primitive. Draw the diameter RCS, and GC*g*, FDH perpendicular to it, meeting the primitive in G *g* F. Divide GC, *g* C, in A, B, in the same proportion as FH is divided in D; and describe the ellipse whose axes are RS, AB, and centre C; and it will be the projection required.

3. When the given points are within the primitive, and not in the same straight line with its centre.

Let D, E (fig. 35.) be the two given points; through C the centre of the primitive draw the straight lines ID *i*, KE *i*; draw DL perpendicular to I *i*, and EO perpendicular to K *k*, meeting the primitive in L, O. Through E, and towards the same parts of C, draw EP parallel to DC, and in magnitude a fourth proportional to LD, DC, OE. Draw the diameter CP meeting the primitive in R, S, and describe an ellipse through the points D and R or S, and it will also pass through E. This ellipse will be the projection of the proposed inclined circle.

PROPOSITION IX. PROBLEM IV.

To describe the projection of a less circle parallel to the primitive, its distance from the pole of the primitive being given.

From the pole of the primitive, with the sine of the given distance of the circle from its pole, describe a circle, and it will be the projection of the given less circle.

PROPOSITION X. PROBLEM V.

About a given point as a projected pole to describe the projection of an inclined circle, whose distance from its pole is given.

Let P (fig. 36.) be the given projected pole, through which draw the diameter G*g*, and draw the diameter H*h* perpendicular thereto. From P draw PL perpendicular to GP meeting the circumference in L; through which draw the diameter L*l*. Make LT, LK each equal to the chord of the distance of the less circle from its pole, and join TK, which intersects L *l*, in Q. From the points T, Q, K draw the lines FA, QS, KB, perpendicular to G*g*; and make OR, OS, each equal to QT, or QK. Then an ellipse described through the points A, S, B, R will be the projection of the proposed less circle.

PROPOSITION XI. PROBLEM VI.

To find the poles of a given projected circle.

1. If the projected circle be parallel to the primitive, the centre of the primitive will be its pole.

2. If the circle be perpendicular to the primitive, then the extremities of a diameter of the primitive drawn at right angles to the straight line representing the projected circle, will be the poles of that circle.

3. When the projected circle is inclined to the primitive.

Let ARBS (fig. 36, 37.) be the elliptical projection of any oblique circle; through the centre of which, and C the centre of the primitive, draw the line of measures CBA, meeting the ellipse in B, A; and the primitive in G, *g*. Draw CH, BK, AT perpendicular to G*g*, meeting the primitive in H, K, T. Bisect the arch KT in L, and draw LP perpendicular to G*g*; then P will be the projected pole of the circle, of which ARBS is the projection.

PROPOSITION XII. PROBLEM VII.

To measure any portion of a projected circle, and conversely.

1. When the given projection is that of a great circle.

Let ADEB (fig. 38.) be the given great circle, either perpendicular or inclined to the primitive, of which the portion DE is to be measured, and let M *m* be the line of measures of the given circle. Through the points D, E draw the lines EG, DF parallel to M *m*; and the arch FG of the primitive will be the measure of the arch DE of the great circle, and conversely.

2. When the projection is that of a less circle parallel to the primitive.

Let DE (fig. 39.) be the portion to be measured, of the less circle DEH parallel to the primitive. From the centre C draw the lines CD, CE, and produce them to meet the primitive in the points B, F. Then the intercepted portion BF of the primitive will be the measure of the given arch DE of the less circle DEH. Plate CCCCXXII.

3. If the given less circle, of which an arch is to be measured, is perpendicular to the primitive.

Let ADEB (fig. 40.) be the less circle, of which the measure of the arch DE is required. Through C, the centre of the primitive, draw the line of measures M *m*, and from the intersection O of the given right circle, and the line of measures, with the radius OA, or OB, describe the semicircle AFGB; through the points D, E draw the lines DF, EG parallel to the line of measures, and the arch FG will be the measure of DE, to the radius AO. In order to find a similar arch in the circumference of the primitive, join OF, OG, and at the centre C of the primitive, make the angle *m* CH equal to FOG, and the arch *m* H to the radius C *m* will be the measure of the arch DE.

4. When the given projection is of a less circle inclined to the primitive.

Let RDS (fig. 41.) be the projection of a less circle inclined to the primitive, and DE a portion of that circle to be measured. Through O the centre of the projected circle, and C the centre of the primitive, draw the line of measures M *m*; and from the centre O, with the radius OR, or OS, describe the semicircle RGFS; through the points D, E draw the lines DF, EG parallel to the line of measures, and FG will be the measure of the arch DE to the radius OR, or OS. Join OF, OG, and make the angle *m* CH equal to FOG,

FOG, and the arch m H of the primitive will be the measure of the arch DE of the inclined circle RDS.

The converse of this proposition, namely, to cut off an arch from a given projected circle equal to a given arch of the primitive, is obvious.

The above operation would be greatly shortened by using the line of sines in the sector.

It seems unnecessary to insist farther on this projection, especially as the reader will see the application of it to the projection of the sphere on the planes of the *Meridian*, *Equator*, and *Horizon* in the article GEOGRAPHY; and to the delineation of *Eclipses* in the article ASTRONOMY. The *Analemma*, Plate CCXII. in the article GEOGRAPHY, is also according to this projection; and the method of applying it to the solution of astronomical problems is there exemplified.

SECTION III.

Of the Gnomonic Projection of the Sphere.

IN this projection the eye is in the centre of the sphere, and the plane of projection touches the sphere in a given point parallel to a given circle. It is named *gnomonic*, on account of its being the foundation of dialling: the plane of projection may also represent the plane of a dial, whose centre being the projected pole, the semiaxis of the sphere will be the stile or gnomon of the dial.

As the projection of great circles are represented by straight lines, and less circles parallel to the plane of projection are projected into concentric circles; therefore many problems of the sphere are very easily resolved. Other problems, however, become more intricate on account of some of the circles being projected into ellipses, parabolas, and hyperbolas.

PROPOSITION I. THEOREM I.

Every great circle is projected into a straight line perpendicular to the line of measures; and whose distance from the centre is equal to the cotangent of its inclination, or to the tangent of its nearest distance from the pole of the projection.

Plate CCCCXXII. Let BAD (fig. 42.) be the given circle, and let the circle CBED be perpendicular to BAD, and to the plane of projection; whose intersection CF with this last plane will be the line of measures. Now since the circle CBED is perpendicular both to the given circle BAD and to the plane of projection, the common section of the two last planes produced will therefore be perpendicular to the plane of the circle CBED produced, and consequently to the line of measures: hence the given circle will be projected into that section; that is, into a straight line passing through d, perpendicular to Cd. Now Cd is the cotangent of the angle CdA, the inclination of the given circle, or the tangent of the arch CD to the radius AC.

COROLLARIES.

1. A great circle perpendicular to the plane of projection is projected into a straight line passing through the centre of projection; and any arch is projected into its correspondent tangent.

2. Any point, as D, or the pole of any circle, is projected into a point d, whose distance from the pole of projection is equal to the tangent of that distance.

3. If two great circles be perpendicular to each other, and one of them passes through the pole of projection, they will be projected into two straight lines perpendicular to each other.

4. Hence if a great circle be perpendicular to several other great circles, and its representation pass through the centre of projection; then all these circles will be represented by lines parallel to one another, and perpendicular to the line of measures, for representation of that first circle.

PROPOSITION II. THEOREM II.

If two great circles intersect in the pole of projection, their representations will make an angle at the centre of the plane of projection, equal to the angle made by these circles on the sphere.

For since both these circles are perpendicular to the plane of projection, the angle made by their intersections with this plane is the same as the angle made by these circles.

PROPOSITION III. THEOREM III.

Any less circle parallel to the plane of projection is projected into a circle whose centre is the pole of projection, and its radius is equal to the tangent of the distance of the circle from the pole of projection.

Let the circle PI (fig. 42.) be parallel to the plane GF, then the equal arches PC, CI are projected into the equal tangents GC, CH; and therefore C, the point of contact and pole of the circle PI and of the projection, is the centre of the representation G, H.

COROLLARY.

If a circle be parallel to the plane of projection, and 45 degrees from the pole, it is projected into a circle equal to a great circle of the sphere; and therefore may be considered as the primitive circle, and its radius the radius of projection.

PROPOSITION IV. THEOREM IV.

A less circle not parallel to the plane of projection is projected into a conic section, whose transverse axis is in the line of measures; and the distance of its nearest vertex from the centre of the plane of projection is equal to the tangent of its nearest distance from the pole of projection; and the distance of the other vertex is equal to the tangent of the greatest distance.

Any less circle is the base of a cone whose vertex is at A (fig. 43.); and this cone being produced, its intersection with the plane of projection will be a conic section. Thus the cone DAF, having the circle DF for its base, being produced, will be cut by the plane of projection in an ellipse whose transverse diameter is df; and Cd is the tangent of the angle CAD, and Cf the tangent of CAF. In like manner, the cone AFE, having the side AE parallel to the line of measures df, being cut by the plane of projection, the section will be a parabola, of which f is the nearest vertex,

Gnomonic Projection of the Sphere.

tex, and the point into which E is projected is at an infinite distance. Also the cone AFG, whose base is the circle FG, being cut by the plane of projection, the section will be a hyperbola; of which f is the nearest vertex; and GA being produced gives d the other vertex.

Corollaries.

1. A less circle will be projected into an ellipse, a parabola, or hyperbola, according as the distance of its most remote point is less, equal to, or greater than, 90 degrees.

2. If H be the centre, and K, k, l the focus of the ellipse, hyperbola, or parabola; then $\mathrm{HK} = \frac{\mathrm{A}d - \mathrm{A}f}{2}$ for the ellipse; $\mathrm{H}k = \frac{\mathrm{A}d + \mathrm{A}f}{2}$ for the hyperbola; and fn being drawn perpendicular to AE $fl = \frac{n\mathrm{E} + \mathrm{F}f}{2}$ for the parabola.

Proposition V. Theorem V.

Plate CCCXXII.

Let the plane TW (fig. 44.) be perpendicular to the plane of projecton TV, and BCD a great circle of the sphere in the plane TW. Let the great circle BED be projected into the straight line bek. Draw CQS perpendicular to bk, and Cm parallel to it and equal to CA, and make QS equal to Qm; then any angle QSt is the measure of the arch Qt of the projected circle.

Join AQ: then because Cm is equal to CA, the angle QCm equal to QCA, each being a right angle, and the side QC common to both triangles; therefore Qm, or its equal QS, is equal QA. Again, since the plane ACQ is perpendicular to the plane TV, and bQ to the intersection CQ; therefore bQ is perpendicular both to AQ and QS: hence, since AQ and QS are equal, all the angles at S cut the line bQ in the same points as the equal angles at A. But by the angles at A the circle BED is projected into the line bQ. Therefore the angles at S are the measures of the parts of the projected circle bQ; and S is the dividing centre thereof.

Corollaries.

1. Any great circle bQt is projected into a line of tangents to the radius SQ.

2. If the circle bC pass through the centre of projection, then the projecting point A is the dividing centre thereof, and Cb is the tangent of its correspondent arch C B to CA the radius of projection.

Proposition VI. Theorem VI.

Let the parallel circle GLH (fig. 44.) be as far from the pole of projection C as the circle FNI is from its pole; and let the distance of the poles C, P be bisected by the radius AO; and draw bAD perpendicular to AO; then any straight line bQt drawn through b will cut off the arches hl, Fn equal to each other in the representations of these equal circles in the plane of projection.

Let the projections of the less circles be described. Then, because BD is perpendicular to AO, the arches BO, DO are equal; but since the less circles are equally distant each from its respective pole, therefore the arches FO, OH are equal; and hence the arch BF is equal to the arch DH. For the same reason the arches BN, DL are equal; and the angle FBN is equal to the angle LDH; therefore, on the sphere, the arches FN, HL are equal. And since the great circle BNLD is projected into the straight line bQn l, &c. therefore n is the projection of N, and l that of L; hence fn, hl, the projections of FN, HL respectively, are equal.

Proposition VII. Theorem VII.

If Fnk, hlg (fig 45.) be the projections of two equal circles, whereof one is as far from its pole P as the other from its pole C, which is the centre of projection; and if the distance of the projected poles C, p be divided in o, so that the degrees in Co, op be equal, and the perpendicular oS be erected to the line of measures gh. Then the line pn, Cl drawn from the poles C, p, through any point Q in the line oS, will cut off the arches Fn, hl equal to each other, and to the angle QCp.

The great circle AO perpendicular to the plane of the primitive is projected into the straight line oS perpendicular to gh, by Prop. i. Cor. 3. Let Q be the projection of q; and since pQ, CQ are straight lines, they are therefore the representations of the arches Pq, Cq of great circles. Now since PqC is an isosceles spherical triangle, the angles PCQ, CPQ are therefore equal; and hence the arches Pq, Cq produced will cut off equal arches from the given circles FI, GH, whose representations Fn, hl are therefore equal: and since the angle QCp is the measure of the arch hl, it is also the measure of its equal Fn.

Corollary.

Hence, if from the projected pole of any circle a perpendicular be erected to the line of measures, it will cut off a quadrant from the representation of that circle.

Proposition VIII. Theorem VIII.

Let Fnk (fig. 45.) be the projection of any circle FI, and p the projection of its pole P. If Cg be the cotangent of CAP, and gB perpendicular to the line of measures gC, let CAP be bisected by AO, and the line oB drawn to any point B, and also pB cutting Fnk in d; then the angle goB is the measures of the arch Fd.

The arch PG is a quadrant, and the angle $go\mathrm{A} = g\mathrm{PA} + o\mathrm{AP} = g\mathrm{AC} + o\mathrm{AP} = g\mathrm{AC} + \mathrm{CA}o = g\mathrm{A}o$; therefore $g\mathrm{A} = go$; consequently o is the dividing centre of gB, the representation of GA; and hence, by Prop. v. the angle goB is the measure of gB. But since pg represents a quadrant, therefore p is the pole of gB; and hence the great circle pdB passing through the pole of the circles gB and Fn will cut off equal arches in both, that is, Fd = gB = angle goB.

Corollary.

The angle goB is the measure of the angle gpB.

For

Gnomonic Projection of the Sphere.

For the triangle $g p$ B represents a triangle on the sphere, wherein the arch which g B represents is equal to the angle which the angle p represents; because $g p$ is a quadrant; therefore $g o$ B is the measure of both.

Proposition IX. Problem I.

To draw a great circle through a given point, and whose distance from the pole of projection is equal to a given quantity.

Plate CCCCXXII.

Let ADB (fig. 46.) be the projection, C its pole or centre, and P the point through which a great circle is to be drawn: through the points P, C draw the straight line PCA, and draw CE perpendicular to it: make the angle CAE equal to the given distance of the circle from the pole of projection C; and from the centre C, with the radius CE, describe the circle EFG: through P draw the straight line PIK, touching the circle EFG in I, and it will be the projection of the great circle required.

Proposition X. Problem II.

To draw a great circle perpendicular to a great circle which passes through the pole of projection, and at a given distance from that pole.

Let ADB (fig. 46.) be the primitive, and CI the given circle: draw CL perpendicular to CI, and make the angle CLI equal to the given distance: then the straight line KP, drawn through I parallel to CL, will be the required projection.

Proposition XI. Problem III.

At a given point in a projected great circle, to draw another great circle to make a given angle with the former; and, conversely, to measure the angle contained between two great circles.

Let P (fig. 47.) be the given point in the given great circle PB, and C the centre of the primitive: through the points P, C draw the straight line PCG; and draw the radius of the primitive CA perpendicular thereto; join PA; to which draw AG perpendicular: through G draw BGD at right angles to GP, meeting PB in B; bisect the angle CAP by the straight line AO; join BO, and make the angle BOD equal to that given; then DP being joined, the angle BPD will be that required.

If the measure of the angle BPD be required, from the points B, D draw the lines BO, DO, and the angle BOD is the measure of BPD.

Proposition XII. Problem IV.

To describe the projection of a less circle parallel to the plane of projection, and at a given distance from its pole.

Let ADB (fig. 46.) be the primitive, and C its centre: set the distance of the circle from its pole, from B to H, and from H to D; and draw the straight line AED, intersecting CE perpendicular to BC, in the point E: with the radius CE describe the circle EFG, and it is the projection required.

Proposition XIII. Problem V.

To draw a less circle perpendicular to the plane of projection.

Let C (fig. 48.) be the centre of projection, and TI a great circle parallel to the proposed less circle: at C make the angles ICN, TCO each equal to the distance of the less circle from its parallel great circle TI: let CL be the radius of projection, and from the extremity L draw LM perpendicular thereto; make CV equal to LM; or CF equal to CM: then with the vertex V and assymptotes CN, CO describe the hyperbola WVK †; or, with the focus F and CV describe the hyperbola, and it will be the perpendicular circle described.

Plate CCCCXXII.

† See Conic Sections.

Proposition XIV. Problem VI.

To describe the projection of a less circle inclined to the plane of projection.

Draw the line of measures dp (fig. 49.) and at C, the centre of projection, draw CA perpendicular to dp, and equal to the radius of projection: with the centre A, and radius AC, describe the circle DCFG; and draw RAE parallel to dp: then take the greatest and least distances of the circle from the pole of projection, and set them from C to D and F respectively, for the circle DF; and from A, the projecting point, draw the straight lines AFf, and ADd; then df will be the transverse axis of the ellipse: but if D fall beyond the line RE, as at G, then from G draw the line GADd, and df is the transverse axis of an hyperbola: and if the point D fall in the line RE, as at E, then the line AE will not meet the line of measures, and the circle will be projected into a parabola whose vertex is f: bisect df in H, the centre, and for the ellipse take half the difference of the lines Ad, Af, which laid from H will give K the focus: for the hyperbola, half the sum of Ad, Af being laid from H, will give k its focus: then with the transverse axis df, and focus K, or k, describe the ellipse dMf, or hyperbola fm, which will be the projection of the inclined circle: for the parabola, make EQ equal to Ff, and draw fn perpendicular to AQ, and make fk equal to one half of nQ: then with the vertex f, and focus k, describe the parabola fm, for the projection of the given circle FE.

Proposition XV. Problem VII.

To find the pole of a given projected circle.

Let DMF (fig. 50.) be the given projected circle, whose line of measures is DF, and C the centre of projection; from C draw the radius of projection CA, perpendicular to the line of measures, and A will be the projecting point: join AD, AF, and bisect the angle DAF by the straight line AP; hence P is the pole. If the given projection be an hyperbola, the angle fAG (fig. 49.), bisected, will give its pole in the line of measures; and in a parabola, the angle fAE bisected will give its pole.

Proposition XVI. Problem VIII.

To measure any portion of a projected great circle, or to lay off any number of degrees thereon.

Let EP (fig. 51.) be the great circle, and IP a portion thereof to be measured: draw ICD perpendicular to IP; let C be the centre, and CB the radius of projection, with which describe the circle EBD; make IA

IA equal to IB; then A is the dividing centre of EP; hence AP being joined, the angle IAP is the meaſure of the arch IP.

Or, if IAP be made equal to any given angle, then IP is the correſpondent arch of the projection.

PROPOSITION XVII. PROBLEM IX.

To meaſure any arch of a projected leſs circle, or to lay off any number of degrees on a given projected leſs circle.

Plate CCCXXIII. Let F n (fig. 52.) be the given leſs circle, and P its pole: from the centre of projection C draw CA perpendicular to the line of meaſures GH, and equal to the radius of projection; join AP, and biſect the angle CAP by the ſtraight line AO, to which draw AD perpendicular: deſcribe the circle G l H, as far diſtant from the pole of projection C as the given circle is from its pole P; and through any given point n, in the projected circle F n, draw D n l, then H l is the meaſure of the arch F n.

Or let the meaſure be laid from H to l, and the line D l joined will cut off F n equal thereto.

PROPOSITION XVIII. PROBLEM X.

To deſcribe the gnomonic projection of a ſpherical triangle, when three ſides are given; and to find the meaſures of either of its angles.

Let ABC (fig. 53.) be a ſpherical triangle whoſe three ſides are given: draw the radius CD (fig. 54.) perpendicular to the diameter of the primitive EF; and at the point D make the angles CDA, CDG, ADI, equal reſpectively to the ſides AC, BC, AB, of the ſpherical triangle ABC (fig. 53.), the lines DA, DG interſecting the diameter EF, produced if neceſſary in the points A and G: make DI equal to DG; then from the centre C, with the radius CG, deſcribe an arch; and from A, with the diſtance AI, deſcribe another arch, interſecting the former in B; join AB, CB, and ACB will be the projection of the ſpherical triangle (fig. 53.); and the rectilineal angle ACB is the meaſure of the ſpherical angle ACB (fig. 53).

PROPOSITION XIX. PROBLEM XI.

The three angles of a ſpherical triangle being given, to project it, and to find the meaſures of the ſides.

Let ABC (fig. 55.) be the ſpherical triangle of which the angles are given: conſtruct another ſpherical triangle EFG, whoſe ſides are the ſupplements of the given angles of the triangle ABC; and with the ſides of this ſupplemental triangle deſcribe the gnomonic projection, &c. as before.

It may be obſerved, that the ſupplemental triangle EFG has alſo a ſupplemental part EF g; and when the ſides GE, GF, which are ſubſtituted in place of the angles A, B, are obtuſe, their ſupplements g E, g F are to be uſed in the gnomonic projection of the triangle.

PROPOSITION XX. PROBLEM XII.

Given two ſides, and the included angle of a ſpherical triangle, to deſcribe the gnomonic projection of that triangle, and to find the meaſures of the other parts.

Let the ſides AC, CB, and the angle ACB (fig. 53.), be given: make the angles CDA, CDG (fig. 56.) equal reſpectively to the ſides AC, CB (fig. 53.); alſo make the angle ACB (fig. 56.) equal to the ſpherical angle ACB (fig. 53.), and CB equal to CG, and ABC will be the projection of the ſpherical triangle.

To find the meaſure of the ſide AB: from C draw CL perpendicular to AB, and CM parallel thereto, meeting the circumference of the primitive in M; make LN equal to LM; join AN, BN, and the angle ANB will be the meaſure of the ſide AB.

To find the meaſure of either of the ſpherical angles, as BAC: from D draw DK perpendicular to AD, and make KH equal to KD: from K draw KI perpendicular to CK, and let AB produced meet KI in I, and join HI: then the rectilineal angle KHI is the meaſure of the ſpherical angle BAC. By proceeding in a ſimilar manner, the meaſure of the other angle will be found.

PROPOSITION XXI. PROBLEM XIII.

Two angles and the intermediate ſide given, to deſcribe the gnomonic projection of the triangle; and to find the meaſures of the remaining parts.

Let the angles CAB, ACB, and the ſide AC of the ſpherical triangle ABC (fig. 53.), be given: make the angle CDA (fig. 56.) equal to the meaſure of the given ſide AC (fig. 53.); and the angle ACB (fig. 56.) equal to the angle ACB (fig. 53.); produce AC to H, draw DK perpendicular to AD, and make KH equal to KD; draw KI perpendicular to CK, and make the angle KHI equal to the ſpherical angle CAB: from I, the interſection of KI, HI, to A draw IA, and let it interſect CB in B, and ACB will be the gnomonic projection of the ſpherical triangle ACB (fig. 53). The unknown parts of this triangle may be meaſured by laſt problem.

PROPOSITION XXII. PROBLEM XIV.

Two ſides of a ſpherical triangle, and an angle oppoſite to one of them given, to deſcribe the projection of the triangle; and to find the meaſure of the remaining parts.

Let the ſides AC, CB, and the angle BAC of the ſpherical triangle ABC (fig. 53.) be given: make the angles CDA, CDG (fig. 56.) equal reſpectively to the meaſures of the given ſides AC, BC: draw DK perpendicular to AD, make KH equal to DK, and the angle KHI equal to the given ſpherical angle BAC: draw the perpendicular KI, meeting HI in I; join AI; and from the centre C, with the diſtance CG, deſcribe the arch GB, meeting AI in B, join CB, and ABC will be the rectilineal projection of the ſpherical triangle ABC (fig. 53.) and the meaſures of the unknown parts of the triangle may be found as before.

PROPOSITION XXIII. PROBLEM XV.

Given two angles, and a ſide oppoſite to one of them, to deſcribe the gnomonic projection of the triangle, and to find the meaſures of the other parts.

Let the angles A, B, and the ſide BC of the tri-

 angle

Gnomonic Projection of the Sphere.

Plate CCCCXXIII.

angle ABC (fig. 55.), be given: let the supplemental triangle EFE be formed, in which the angles E, F, G, are the supplements of the sides BC, CA, AB respectively, and the sides EF, FG, GE, the supplements of the angles C, A, B. Now, at the centre C (fig. 56.) make the angles CDA, CDK equal to the measures of the sides GE, GF respectively, being the supplements of the angles B and A; and let the lines DA, DK intersect the diameter of the primitive EF, in the points A and K: draw DG perpendicular to AD, make GH equal to DG, and at the point H make the angle GHI equal to the angle E, or to its supplement; and let EI, perpendicular to CH, meet HI in I, and join AI: then from the centre C, with the distance CG, describe an arch intersecting AI in B; join CB, and ABC will be the gnomonic projection of the given triangle ABC (fig. 55.): the supplement of the angle ACB (fig. 56.) is the measure of the side AB, (fig. 55.); the measures of the other parts are found as before.

It has already been observed, that this method of projection has, for the most part, been applied to dialling only. However, from the preceding propositions, it appears that all the common problems of the sphere may be more easily resolved by this than by either of the preceding methods of projection; and the facility with which these problems are resolved by this method has given it the preference in dialling. It may not perhaps be amiss, in this place, to give a brief illustration of it in this particular branch of science.

In an horizontal dial, the centre of projection Z (fig. 57.) represents the zenith of the place for which the dial is to be constructed; ZA the perpendicular height of the style: the angle ZPA, equal to the given latitude, determines the distance ZP of the zenith from the pole; and AP the edge of the style, which by its shadow gives the hour: the angle ZAP, equal also to the latitude, gives the distance of the equator EQ from the zenith: let E *a* be equal to EA, and *a* will be the dividing point of the equator. Hence if the angles E *a* I, E *a* II, &c. E *a* XI, E *a* X, &c. be made equal to 15°, 30°, &c. the equator will be divided into hours; and lines drawn from P to these points of division will be hour lines.

If the dial is either vertical, or inclined to the horizon, then the point Z will be the zenith of that place whose horizon is parallel to the plane of the dial: ZE will be the latitude of that place; and the hours on the former dial will now be changed into others, by a quantity equal to the difference of longitude between the given place and that for which the dial is to be constructed. Thus if it is noon when the shadow of the style falls on the line *P* X, then the difference of meridians is the angle E *a* X, or 30°. Hence, when a dial is to be constructed upon a given plane, either perpendicular or inclined to the horizon, the declination and inclination of that plane must be previously found.

In an erect direct south dial, its zenith Z is the south point of the horizon, ZP is the distance of this point from the pole, and ZE its distance from the equator. If the dial is directed to the north, Z represents the north point of the horizon; PZ the distance of Z from the pole under the horizon; and ZE the elevation of the equator above the horizon.

If the dial is an erect east or west dial, the zenith Z is the east or west points of the horizon accordingly, and the pole P is at an infinite distance, for the angle ZAP is a right angle; and therefore the line AP will not meet the meridian PZ. The line ZA produced is the equator, and is divided into hours by lines perpendicular to it.

If the plane of the dial is parallel to the equator, its zenith Z coincides with one of the poles of the equator P; and hence the hour lines of this dial are formed by drawing lines from the point Z, containing angles equal to 15°.

In the preceding methods of projection of the sphere, equal portions of a great circle on the sphere are represented by unequal portions in the plane of projection, and this inequality increases with the distance from the centre of projection. Hence, in projections of the earth, those places towards the circumference of the projection are very much distorted. In order to avoid this inconveniency, M. de la Hire * proposed, that the eye should be placed in the axis produced at the distance of the sine of 45° beyond the pole: In this case arches of the sphere and their projections are very nearly proportional to each other. Hence in a map of the earth agreeable to this construction, the axis, instead of being divided into a line of semitangents, is divided equally, in like manner as the circumference. The map of the world, Plate CCXIV, is constructed agreeable to this method of projection.

* *Hist. l'Academ. R. des Sc.* 1701. See also article *Geography*, p. 650.

PRO

Projection.

PROJECTION, in perspective, denotes the appearance, or representation of an object on the perspective plane.

The projection, *e. gr.* of a point, as B (Fig. 1. Plate CCCLXXXIII.) is a point *b*, through which the optic ray BE passes from the objective point through the plane to the eye; or it is the point wherein the plane cuts the optic ray.

And hence is easily conceived what is meant by the projection of a line, a plane, or a solid.

Projection in Alchemy, the casting of a certain imaginary powder, called *powder of projection*, into a crucible, or other vessel, full of some prepared metal, or other matter; which is to be hereby presently transmuted into gold.

Projection, Projecture.

Powder of Projection, or of the philosophers stone, is a powder supposed to have the virtue of changing any quantity of an imperfect metal, as copper or lead, into a more perfect one, as silver or gold, by the admixture of a little quantity thereof.

The mark to which alchemists direct all their endeavours, is to find the powder of projection; which every one of them has been within an ace of a hundred times. See *Philosopher's Stone.*

PROJECTURE, in architecture, the outjetting and prominency, or embossing, which the mouldings an

and other members have beyond the naked wall, column, &c.

PROLAPSUS, in ſurgery, a prolapſion or falling out of any part of the body from its natural ſituation: thus we ſay, *prolapſus inteſtini*, "a prolapſion of the inteſtine," &c. See SURGERY.

PROLATE, in geometry, an epithet applied to a ſpheroid produced by the revolution of a ſemi-ellipſis about its larger diameter. See SPHEROID.

PROLEGOMENA, in philology, certain preparatory obſervations or diſcourſes prefixed to a book, &c. containing ſomething neceſſary for the reader to be appriſed of, to enable him the better to underſtand the book, or to enter deeper into the ſcience, &c.

PROLEPSIS, a figure in rhetoric, by which we anticipate or prevent what might be objected by the adverſary. See ORATORY, n° 80.

PROLEPTIC, an epithet applied to a periodical diſeaſe which anticipates, or whoſe paroxyſm returns ſooner and ſooner every time; as is frequently the caſe in agues.

PROLIFER FLOS; (*proles*, "an offspring;" and *fero*, "to bear);" a prolific flower, or a flower which from its own ſubſtance produces another; a ſingular degree of luxuriance, to which full flowers are chiefly incident. See BOTANY, p. 428.

PROLIFIC, ſomething that has the qualities neceſſary for generating.

The prolific powers of ſome individuals among mankind are very extraordinary.—Inſtances have been found where children, to the number of ſix, ſeven, eight, nine, and ſometimes ſixteen, have been brought forth after one pregnancy. The wife of Emmanuel Gago, a labourer near Valladolid, was delivered, the 14th of June 1779, of five girls, the two firſt of whom were baptized: the other three were born in an hour after; two of them were baptized; but the laſt, when it came into the world, had every appearance of death. The celebrated Tarſin was brought to bed in the ſeventh month of her pregnancy, at Argenteuil near Paris, 17th July 1779, of three boys, each 14 inches and a half long, and of a girl 13 inches: they were all four baptized, but did not live 24 hours.

The public papers for the month of June 1779 made mention of one Maria Ruiz, of the diſtrict of Lucena in Andaluſia, who was ſucceſſively delivered of 16 boys, without any girls; and ſeven of them were ſtill alive on the 17th of Auguſt thereafter. The following, though a recent fact, is almoſt incredible: In the year 1755, a Muſcovite peaſant, named *James Kyrloff*, and his wife, were preſented to the Empreſs of Ruſſia. This peaſant had been twice married, and was then 70 years of age. His firſt wife was brought to bed 21 times; namely, four times of four children each time; ſeven times of three, and ten times of two; making in all 57 children, who were then alive. His ſecond wife, who accompanied him, had already been delivered ſeven times, once of three children, and ſix times of twins, which made 15 children for her ſhare. Thus the Muſcovite patriarch had already had 72 children by two marriages. We are aſſured that the ſultan Muſtapha III. had iſſue by his concubines 580 male children. What number of female children he had, and whether there were twins of both ſexes, we are not informed. Theſe facts ſuppoſe great fecundity; and whatever credit is given to them, we muſt conſider as entirely fabulous what is reported concerning a counteſs of Holland who was delivered of 365 children, of a very ſmall ſize.

PROLIXITY, in diſcourſe, the fault of entering into too minute a detail, or being too long, preciſe, and circumſtantial, even to a degree of tedioufneſs.

PROLOCUTOR of the convocation, the ſpeaker or chairman of that aſſembly. See CONVOCATION.

PROLOGUE, in dramatic poetry, a diſcourſe addreſſed to the audience before the drama or play begins. The original intention was to advertiſe the audience of the ſubject of the piece, and to prepare them to enter more eaſily into the action, and ſometimes to make an apology for the poet.

PROMETHEUS, the ſon of Japetus, ſuppoſed to have been the firſt diſcoverer of the art of ſtriking fire by flint and ſteel; which gave riſe to the fable of his ſtealing fire from heaven: A renowned warrior; but whoſe hiſtory is involved in fable. He flouriſhed about 1687 B. C. The poetical account is, that he formed a man of clay of ſuch exquiſite workmanſhip, that Pallas, charmed with his ingenuity, offered him whatever in heaven could contribute to finiſh his deſign; and for this purpoſe took him up with her to the celeſtial manſions, where he ſtole ſome fire from the chariot of the ſun, which he uſed to animate his image. At this theft Jupiter was ſo enraged, that he ordered Vulcan to chain him down on Mount Caucaſus, and ſent an eagle or vulture to prey on his liver; which every night was renewed, in proportion to the quantity eaten up in the day-time, until at laſt he was delivered by Hercules, who killed the vulture.

PROMETHEUS, in ancient aſtronomy, was the name of a conſtellation of the northern hemiſphere, now called *Hercules*, *Engonaſin*. See ASTRONOMY, n° 406.

PROMISE, in ordinary caſes, is a declaration of ſome intention to be put in execution; but in morals is a ſolemn aſſeveration by which one pledges his veracity that he ſhall perform, or cauſe to be performed, the thing which he mentions. 1 Promiſe defined.

As ſuch a declaration excites expectations in the minds of thoſe to whom it is made; and as to fruſtrate theſe expectations might rouſe indignation, and be followed by conſequences injurious to the perſon, the character, or intereſt, of him who made it—it becomes a matter of prudence in the promiſer to keep his word. And farther, as a certain degree of confidence is found neceſſary to the very exiſtence of civil ſociety, and as others may have acted on the faith of his promiſe, it is now not a matter of prudence only to keep his word—it is a duty which he owes to all who have ſpent their time, their money, or their labour, in conſequence of thoſe expectations which he has warranted them to entertain. 2 How it comes to be binding.

It, then, being conſonant to ſound reaſon, neceſſary to the exiſtence of civil ſociety, and in general the intereſt of both the promiſer and promiſee, that the words of the promiſe ſhould be fulfilled, it has become a maxim in morals that a man is obliged to perform his promiſe.

In many inſtances, the great difficulty concerning a promiſe is, how to explain it; for although the grounds of its obligation be thoſe expectations which it has raiſed, a queſtion will occur, Is the promiſer bound to 3 Interpretation of a promiſe ſometimes difficult.

anſwer

Promise. answer fully all the expectations to which the different constructions of his words may have given birth? Should I, for instance, desire a man to run with a letter to such a place, and engage to satisfy him upon his return; and if on his return I gave him double of the usual hire in like cases; but if he be not satisfied with less than the triple of such a sum, am I obliged to grant his demands? This will lead us to consider the rules by which a promise should be interpreted.

4 Whether the meaning of the promiser or promisee ought to be taken.

If a promise were always to be deemed obligatory in the sense in which the promisee receives it, a man would not know what he had promised; the promisee, from a difference of views, associations, and interests, might conceive a sense of which the promiser had never dreamed; might suppose engagements which were never intended, which could not be foreseen, and, although foreseen, could not be performed. For these reasons it is natural to think that the sense of the promiser should rather direct the interpretation. He knows precisely what it is he has undertaken, and is unquestionably the best judge of what meaning he affixed to his words. His explanation should therefore be admitted, if information alone could give him a title to decide in the affair.

But something more than mere information, or a knowledge of the cause, is expected from a judge, as integrity is equally essential to his character. Doubts may arise when the words will admit of various meanings, whether the promiser will be so candid as impartially to own the precise meaning which he had actually annexed to his expressions: At any rate, if he wished to deceive, he might purposely use an ambiguous phraseology, and perform the promise in a sense of his own without satisfying the reasonable hopes of the promisee.

When the daughter of Tarpeius bargained with Tatius to betray the citadel for what he and his Sabines wore on their left hands, meaning their rings and their golden bracelets, Tatius probably performed his promise in the way which he intended, when he caused her to be buried under their shields, which they carried also on their left hands. But who will say that here was not treachery and a dishonourable abuse of that confidence which had been reposed in him?

5 In doubtful cases the interpretation of neither is to be trusted.

It must therefore be obvious, that the import of a promise, where its meaning is disputed, is not to be determined by the sense of the promiser nor by the expectations of the promisee; and if it was said that the obligation of a promise arose from those expectations which had been raised by it, the assertion now must be limited to those expectations which were intentionally raised by the promiser, or those which to his knowledge the promisee was induced to entertain in consequence of that declaration which had been made to him. Should there still be a doubt about what expectations were intentionally raised, and what should have been reasonably entertained, recourse must be had to the judgment of those who are allowed to be persons of candour, and who are acquainted with the characters of the men, and with those circumstances in which the promise was made.

6 Cases where a promise is not binding.

The following are some of the cases in which a promise is not binding. As the obligation to perform the promise arises from those expectations which are intentionally raised by the promiser; it is plain that no promise can be binding before acceptance, before the promise has been communicated to the promisee, and before he has entertained hopes of its performance. The case is similar where a promise is released, that is, where the performance is dispensed with by the promisee, and where he entertains no expectations on account of any thing that the promiser has said to him. Should a third person entertain hopes on account of the promise, he is to cherish these hopes at his own hazard, having no encouragement from the promiser to do so: yet if this person has been warranted to hope by the promisee, the promisee has renounced his privilege of releasing the promise, and along with the promiser becomes bound for its performance.

7 When released by the promisee.

8 Where performance is unlawful.

A promise is not binding where the performance is unlawful; and the performance is unlawful where it is contrary to former promises, or to any moral and religious precept, which from the beginning to the end of time is of perpetual and unalterable obligation. Thus no man is bound by his promise to give to me what he has already promised to another; and no man is bound by his promise to blaspheme God, to commit murder, or to criminate the innocent. Such promises are unlawfully made, and cannot be otherwise than unlawfully performed.

9 A case where doubts arisen.

Some have even carried their scruples so far as to doubt, whether any promise, unlawfully made, can be lawfully performed. Should a man, during the lifetime of his wife, happen to promise marriage to another, such a man (they say) by the Christian religion has already committed adultery in his heart; and should he afterwards become a widower, he is not bound, and he even ought not, to fulfil his engagements, as this would be putting his criminal intention into execution. This species of reasoning, we must confess, is to us unintelligible.—As the wife is dead, what now should prevent the man from marrying the object of his affections? Why, say the casuists, he already is under a promise to marry her, and his promise was made at a time when it should not have been made. It is true, the performance, considered by itself, is opposed by no law human or divine; but then it originated in what was wrong; and however much the Supreme Being and the bulk of the creation may be out of the secret, we have discovered by the ingenious logic of casuistry, that evil can never spring out of good, nor good out of evil; but that the means and the end, the motive and the action are always of the same complexion in morals.

10 Erroneous promises.

When a promise is made, the particular circumstances in which it is to be deemed obligatory are sometimes mentioned. "I promise (for instance) to lend my friend 200 pounds within three days, provided a certain creditor which I name do not make a demand on me before that time. In other cases no circumstance is foreseen by the promiser to prevent the fulfilling of his engagement; and hence we have erroneous promises, which proceed on the supposition that things are true, possible, and lawful, which are not so. An erroneous promise, which proceeds on the false representation of the promisee, is not binding.

A London gentleman lately purchased an estate in the south of England at a public sale, believing the description which he saw in the newspapers, and which likewise was given by the auctioneer, to be true; but finding afterwards that the estate nowise corresponded to the description, the law freed him from his engagement, because the seller had evidently been guilty of a

a breach of promise in not satisfying those expectations which he had intentionally and even studiously excited in the buyers.

11 Promise binding when the performance is impossible,

An erroneous promise, whose performance is impossible, is not binding. Before the conclusion of the late war a planter of Tobago promised to send to his friend in England 12 hogsheads of sugar from the next year's produce of his estate; but before that time Tobago fell into the hands of the French, and the West Indian found it impossible to answer the expectations of his friend in England.

12 or when unlawful.

An erroneous promise, whose performance is unlawful, or, to speak more precisely, whose performance is contrary to a prior promise, or to any moral or religious obligation, is not binding. A father believing the accounts from abroad of his son's death, soon after bequeathes his fortune to his nephew: but the son, the report of whose death had been false, returns home, and the father is released from the promise to his nephew, because it was contrary to a prior promise, which he had tacitly come under to his son. This prior promise was implied in the whole of the father's conduct, and was expressed in signs as emphatic and as unequivocal as those of language. It had all the effect too of the most solemn promise on the son, who, to his father's knowledge, was induced in consequence of this promise to entertain the most sanguine hopes of succeeding to his father, if he survived. The world likewise could bear testimony that these expectations were not rashly cherished. He was brought into existence by means of his father, who was thereby understood to love him affectionately; he was ushered into society as the representative of his family, and was therefore supposed to be the heir of its wealth. Religion itself supported his pretensions, pronouncing the father worse than an infidel who neglects to show that attention to his children which the world naturally expects from a parent.—That the father's promise was not released from the mere circumstance that the mistake was known to his nephew the promisee, will appear plain from the following circumstance. Suppose the father a landed proprietor, that the lease of one of his farms has expired, and that he has long been expecting to let it at L. 200; suppose that this sum is refused, and that he agrees with the present tenant to grant a new lease at L. 150—the obligation here to perform his promise is not dissolved by an after offer of L. 200, though the tenant knew that L. 200 had been expected, and that only from despairing of that sum his landlord had granted the new lease at L. 150: the promise is binding, because the performance is every way lawful, contrary to no prior engagement, and opposed to no principle in morals. The law of the land, were the proprietor reluctant, would enforce the obligation, and exact obedience in the tone of authority; because breaches of faith, were they permitted in such cases, would destroy all confidence, and annihilate the bonds of social union:

> Men live and prosper but in mutual trust;
> A confidence of one another's truth. *Oroonoko.*

13 (It) no ...ion ...eby to ...e of validity ...omises.

The great difficulty which many have to encounter in determining when erroneous promises ought or ought not to be kept, arises from their proceeding on a principle of whose consequences they do not seem to be always aware. There is seldom, they perceive, a virtuous action that is not attended with some happy effects; and it will, perhaps, be generally allowed, that the comparative merit of similar virtues may safely be estimated by their utility: But to make utility, as some do, the criterion of virtue, and pronounce an action vicious or virtuous merely on account of those consequences which they see may flow from it, is a dangerous maxim. Evil has often sprung out of good, and good out of evil; and good and evil have frequently sprung from the same action. In Mandeville's *Hive*,

14 This principle would give a sanction to vice and falsehood.

> That root of evil Avarice,
> That damn'd ill-natur'd baneful vice,
> Was slave to Prodigality,
> That noble sin; whilst Luxury
> Employ'd a million of the poor,
> And odious Pride a million more.
> Envy itself and Vanity
> Were ministers of Industry:
> That darling folly, Fickleness,
> In diet, furniture, and dress,
> That strange ridiculous vice, was made
> The very wheel that turn'd the trade.

The description here is not altogether false; and these indeed may be some of the consequences that flow from avarice, luxury, pride, vanity, and envy: but these are not all.—To see at once all the consequences that spring from an action, the good and the bad, the particular and general, the immediate and remote, would require sometimes the foresight of Omniscience, and at all times a knowledge superior to what is human. In the Fable of the Bees, the author's object was to show that private vices are public benefits; and he therefore was naturally led by his argument to consider only such consequences of vice as favoured his hypothesis. He wanted candour. And that artifice which runs through his Fable happens to remind us, that while the remote and the general effects of an action may not be seen, the particular and immediate, which fall within our notice, are apt to be viewed through the medium of passion, interest, or opinion. For these reasons, it appears surprising how any person should ever imagine that the obligation to perform a promise should depend entirely upon the ideas which the promiser apprehended of its utility.

The best refutation of such an opinion are the singular conclusions to which it leads.

15 The consequences that flow from it ridiculous and absurd.

A late writer on political justice, who appears to have embraced it, gets into reasoning not very common. In a part of his system he looks on morals as an article of trade: virtue and vice, in his Chapter of *Promises*, are but antiquated terms for profit and loss; and right and wrong are used to express what is beneficial and what is hurtful, in his apprehension, to himself and the community.—With respect to veracity, those "rational and intelligent beings," by whom he wishes the affairs of the world to be carried on, may, while they act as rational and intelligent, break or perform their promises at pleasure. He thinks it "essential to various circumstances of human intercourse, that we should be known to bestow a steady attention upon the quantities of convenience or inconvenience, of good or evil, that might arise to others from our conduct." After this attention, the disappointment of the promisee is not to be minded,

Promise.

minded, though the expectations excited by these "rational and intelligent beings" may have "altered the nature of his situation, and engaged him in undertakings from which he would otherwise have abstained." What the promiser takes to be the general utility and the fitness of things is to be his guide. And a breach of promise will be attended with the following advantages: "The promisee, and all other men, will be taught to depend more upon their own exertions, and less upon the assistance of others, which caprice may refuse or justice with-hold. He and all others will be taught to acquire such merit, and to engage in such pursuits, as shall oblige any honest man to come to their succour if they should stand in need of assistance." This breach of promise, with a view to the general utility, will, so far from being criminal, form a part of that resolute execution of justice which would in a thousand ways increase the independence, the energies, and the virtue of mankind*."

* Godwin's Inquiry concerning Political Justice, book 3. ch. 3.

Such are the views which determined this author to consider "the validity of promises" as "inconsistent with justice," and as "foreign to general good." From one, however, who relies with so much confidence on the promiser, it would be certainly desirable to know, whether the person, who violates his faith for the public utility, is always to be candid. Where breach of faith promotes his own interest, ought he alone to decide on the validity of his promise? or where promises are broken for the general good, is he to be guided by his own visionary schemes of utility? Is he to act as trustee for the public without any delegated power? and shall the community submit to his decisions without so much as putting the question, Who hath made thee a ruler overs us? When a writer thus deviates so far from the path of reason, it is natural to ask, what was the *ignis fatuus* that misled him? In the present case it is pretty obvious. Being something of opinion with the celebrated Turgot*, that romances are the only books in which moral principles are treated in an impartial manner, this gentleman, in his Chapter of *Promises*, seems to have borrowed a part of his morality from the doggerels of Butler; and having adopted, though from different motives, the political principles of Sir Hudibras's squire, that obedience to civil government is not due because it is promised, he has come to exactly the same conclusion with respect to the obligation of keeping one's word. But Ralph has reasoned with more ingenuity; and has shown not only that the public good, but the glory of the Lord, may be sometimes promoted by a breach of faith.

16 A private individual has no right to intrude his schemes of utility on the public

* See Note, b. iii. ch. 6.

The saints,* whom oaths and vows oblige,
Know little of their privilege;
Farther, I mean, than carrying on
Some self-advantage of their own:
For if the dev'l, to serve his turn,
Can tell truth, why the saints should scorn,
When it serves theirs, to swear and lie,
I think there's little reason why:
Else h' has a greater pow'r than they,
Which 'twere impiety to say:
W are not commanded to forbear,
Indefinitely, at all to swear;
But to swear idly, and in vain,
Without self-interest and gain;
For breaking of an oath and lying
Is but a kind of self-denying,
A saint-like virtue; and from hence
Some have broke oaths by Providence:
Some, to the glory of the Lord,
Perjur'd themselves and broke their word:——
For saints may do the same thing by
The spirit, in sincerity,
Which other men are tempted to,
And at the devil's instance do.

HUDIBRAS, *Cant.* II.

* The saints are Godwin's rational and intelligent beings.

Here are new views of utility; which, were they to be considered as of any weight, would increase the difficulty of determining when an erroneous promise ought to be kept.

But should views of utility be laid aside, and should it be made an invariable rule that truth is on no account to be violated, that deceit is never to be practised, and that moral obligations are not to be dissolved for the prospect of any physical advantage; those doubts which arise concerning the validity of erroneous promises will soon disappear. Disagreeable perhaps and ridiculous consequences may sometimes arise to a few individuals from an honest and conscientious adherence to their promise; but will any assert that the general good, *that burden of the song*, will ever be endangered by too much veracity?

17 Views of utility a[re] unsafe g[uides] in moral[s]

So numerous inconveniences arise daily from the regular operation of those great physical laws, which are under the immediate direction of Providence, that those philosophers who have adopted the principle of utility, and are much surprised to see the universe so aukwardly planned for the ease and comfort of them and their species, have been under the necessity of imputing many events in nature to the malignity of some evil independent being; or of allowing that things have degenerated since they first came from the hands of the Creator, and that they must now be exceedingly altered from what they had been when He chose to pronounce them all very good. Thus, absurdity or impiety must always be the consequence of judging of the vice and virtue of an action by its utility, and of estimating its utility by our limited views and erroneous conceptions.

As for extorted promises, it is curious to observe how this question should always be started, whether or not they ought to be kept? and another question should seldom be thought of, whether or not they ought to be made? Fortitude was one of the cardinal virtues among the ancients; and is deemed of such importance in the Christian system, that the fearful are classed with the unbelievers, and are thought unworthy of the favour of Deity, as being incapable of supporting those trials to which heaven exposes the faithful as the truest test of Christian virtue.—If a person should want the necessary fortitude to be virtuous, it will be a poor excuse for his baseness, that he has added deceit to his cowardice: and surely it is not the business of morality, when it has found him guilty of one crime, to grant him a dispensation for committing two. The laws of jurisprudence, it will readily be allowed, cannot favour the claims of the promisee; because they ought never to

18 Extort[ed] promi[ses]

19 Wheth[er] binding [or] not.

romiſe.

to lend their ſupport to oppreſſion and violence. But their acquittal, ſhould he violate his faith, will by no means vindicate the character of the promiſer. Their acquitting a woman from the charge of adultery, goes a ſhort way in reſtoring the fair reputation of her innocence.

Let juriſprudence decide as it will, the man of honour and the generous patriot can never be brought to reſpect the perſon who, ſtruck with a panic, could betray either himſelf or his friends. The magnanimous ſpirits who could die for the truth will view with contempt his pitiful deceit. Thoſe unfortunate men who may ſuffer from that very diſtruſt which the breach of his faith has begotten, will always deteſt him as a traitor and enemy; and heaven itſelf cannot be ſuppoſed to reward that ſoldier who deſerts her cauſe, and relinquiſhes the poſt which ſhe has aſſigned him, at the ſight of danger.

If we once begin to accommodate morality to the diſpoſitions and humours of mankind, it is hard to ſay where this ſpecies of complaiſance will end. The degrees of timidity are ſo various, and ſome tempers by nature ſo yielding, that repeated importunity or an earneſt requeſt will extort a promiſe.

20
he laws morality e not to accommo- ted to the mours interest mankind.

A young lady was frequently preſſed by her dying huſband to grant him a promiſe that ſhe would not marry after his death. For ſome time ſhe was able to reſiſt with becoming ſpirit his abſurd requeſt; but upon his declaring oftener than once that he could not otherwiſe die in peace, ſhe complied and promiſed. Too young, however, for this effort of continence, ſhe afterwards liſtened to the addreſſes of a ſecond lover, and found her heart inſenſibly engaged before ſhe adverted to the impropriety of a new attachment. But propoſals of marriage could ſcarcely fail to remind her of her promiſe and awaken her ſcruples. Theſe ſhe ſoon communicated to her lover, with her firm reſolution to remain a widow, if the contrary meaſure, which ſhe greatly preferred, and on which her earthly happineſs depended, were not approved by ſome ſpiritual counſellor.

Upon this declaration it was agreed to take the advice of their own miniſter, who was an eminent diſſenting clergyman in the dioceſe of Oxford: but this gentleman, unwilling to decide in a matter of ſuch importance, propoſed to refer it to Dr Secker, who was then biſhop of that ſee. This prelate too declined to give any judgment in the caſe; but, as was his way, muſtered up a number of arguments on each ſide of the queſtion, and committed them to a letter, which a learned gentleman of our acquaintance had ſome time ago an opportunity of ſeeing in manuſcript.

If the ſentiments to which the biſhop was inclined could have been inferred from his ſtatement of arguments, he ſeemed to think that the promiſe was binding. In our opinion, he ought to have given a poſitive deciſion. It was no matter whether the promiſe was extorted or not: the promiſe was made; and the queſtion was now, whether or not was the performance lawful? That it was lawful appears evident. The lady was under a moral obligation to remain a widow; and no moral obligation, ſo far as we know, required her to marry.

To be fruitful and multiply, indeed, is declared in Scripture, and is found, to the woful experience of many, to be one of the general laws of our nature. But of all thoſe laws intended by nature to regulate the conduct of inferior intelligences, the moral, which were meant to be checks and correctors of thoſe abuſes to which the phyſical are apt to be carried, are certainly the moſt ſacred and obligatory. To procreate his ſpecies, a man is not then to be guilty of adultery, nor of fornication, nor to liſten to the lewd calls of incontinency. St Paul's obſervation, that it is better to marry than burn, cannot be allowed in this inſtance to have much weight. He has not defined what degree of amorous inflammation conſtitutes burning, nor in what caſes this burning would be a ſufficient warrant for marrying. In the preſent inſtance he does not even conſider marriage as a duty; he compares it with burning, and thinks it only the leaſt of the two evils. Not that marriage is evil of itſelf; for he that marrieth doth well: but there are circumſtances in which it would be inconvenient to marry, and in which he that marrieth not is ſaid to do better. But if thoſe inconveniences be reaſons ſufficient to deter from marrying, is that perſon to be held excuſable who, in order to gratify an animal paſſion, ſomewhat refined, ſhould violate an oath, and trample on a ſacred moral obligation?

Promiſe.

21
Moral laws ſuperior to phyſical in point of obligation.

The young lady might indeed declare that her earthly happineſs was at an end if ſhe were not permitted to marry again: but what circumſtance prevented her from marrying? It was not the opinion of her own paſtor, nor the biſhop of Oxford: the truth is, it was certain ſcruples of her own, which being unable of herſelf to overcome, ſhe had piouſly ſolicited the aſſiſtance of others. It is certainly a misfortune that a devotional and amorous turn ſhould always be ſo cloſely connected in the females. Both, however, cannot always be indulged. Who will ſay, that the motive is rational which inclines one to cheriſh a paſſion which conſcience diſapproves? The virtue of continency might indeed have borne hard on this lady's conſtitution, and in her way to immortal happineſs might have formed a gate ſo ſtrait and narrow as it might be difficult for her to paſs through: but after all, her caſe was not harder than that of nuns, who take the vows of perpetual chaſtity, and endure ſufferings of a ſimilar nature, and in ſome inſtances even perhaps greater than hers; yet doing it cheerfully, from the ſuppoſition that the Omniſcient is well acquainted with the nature of the great ſacrifice which they make, and that after death he will ſtudy to requite them, and beſtow on them ſomething like an equivalent, which in their opinion can ſcarcely be leſs than a happineſs in heaven as ample as their wiſhes and as laſting as their ſouls.

Every promiſe, therefore, which is not releaſed, nor fraudently obtained by the promiſee, is to be held binding if the performance be lawful and poſſible.

22
A promiſe of a ſimilar nature with an oath.

The Chriſtian cannot, and a man of honour will ſcarcely venture to reject this maxim, that a good man ought not to change though he ſwear to his hurt. Yet a ſimple promiſe and a promiſſory oath are not very different in point of obligation. Moſt people know, and, where any moral duty is concerned, they ought particularly to reflect, that this world is governed by an Almighty Being, who knows all things, who lives always, and who is juſt to reward and to puniſh. The perſon who makes a promiſſory oath does it avowedly under an immediate ſenſe of theſe truths; the perſon who makes a ſimple promiſe, though he certainly ought, yet may not reflect on theſe at the time. The former, when he violates his oath, exhibits, only to outward appearance,

appearance, a greater contempt of the Divine power, knowledge, and juftice, than he who violates a fimple promife under an impreffion of the fame truths. To Him who knows the fecrets of the heart, the breach of the promife muft appear as criminal as the breach of the oath. See ASSUMPSIT and OATH.

PROMONTORY, in geography, a high point of land or rock projecting out into the fea; the extremity of which towards the fea is called a *cape* or *headland*. See Plate CCXII.

PROMPTER, in the drama, an officer pofted behind the fcenes, whofe bufinefs it is to watch attentively the actors fpeaking on the ftage, in order to fuggeft and put them forward when at a ftand, to correct them when amifs, &c. in their parts.

PROMULGATED, or PROMULGED, fomething publifhed or proclaimed, and generally applied to a law, to denote the publifhing or proclaiming it to the people.

PRONAOS, in the ancient architecture, a porch to a church, palace, or other fpacious building. See the article PORCH.

PRONATION, among anatomifts. The radius of the arm has two kinds of motions, the one called *pronation*, the other *fupination*. Pronation is that whereby the palm of the hand is turned downwards; and fupination, the oppofite motion thereto, is that whereby the back of the hand is turned downwards. The peculiar mufcles whereby pronation is performed, are called *pronatores*, as thofe by which fupination is performed are termed *fupinatores*. See ANATOMY, *Table of the Mufcles*, and *Plates*.

PRONG-HOE, in hufbandry, a term ufed to exprefs an inftrument ufed to hoe or break the ground near and among the roots of plants.

The ordinary contrivance of the hoe is very defective, it being only made for fcraping on the furface; but the great ufe of hoeing being to break and open the ground, befide the killing of the weeds, which the ancients, and many among us, have thought the only ufe of the hoe, this dull and blunt inftrument is by no means calculated for the purpofes it is to ferve. The prong-hoe confifts of two hooked points of fix or feven inches long, and when ftruck into the ground will ftir and remove it the fame depth as the plough does, and thus anfwer both the ends of cutting up the weeds and opening the land. It is ufeful even in the horfe-hoeing hufbandry, becaufe the hoe-plough can only come within three or four inches of the rows of the corn, turnips, and the like; whereas this inftrument may be ufed afterwards, and with it the land may be raifed and ftirred even to the very ftalk of the plant. See AGRICULTURE and HOE.

PRONOUN, PRONOMEN, in grammar, a declinable part of fpeech, which being put inftead of a noun, points out fome perfon or thing. See GRAMMAR.

PRONUNCIATION, in grammar, the manner of articulating or founding the words of a language.

Pronunciation makes the moft difficult part of written grammar; in regard that a book expreffing itfelf to the eyes, in a matter that wholly concerns the ears, feems next akin to that of teaching the blind to diftinguifh colours: hence it is that there is no part fo defective in grammar as that of pronunciation, as the writer has frequently no term whereby to give the reader an idea of the found he would exprefs; for want of a proper term, therefore, he fubftitutes a vicious and precarious one. To give a juft idea of the pronunciation of a language, it feems neceffary to fix as nearly as poffible all the feveral founds employed in the pronunciation of that language. Cicero tells us, that the pronunciation underwent feveral changes among the Romans: and indeed it is more precarious in the living languages, being, as Du Bos tells us, fubfervient to fafhion in thefe. The French language is clogged with a difficulty in pronunciation from which moft others are free; and it confifts in this, that moft of their words have two different pronunciations, the one in common profe, the other in verfe.

As to the pronunciation of the Englifh language, the ingenious Mr Martin, in his Spelling-Book of Arts and Sciences, lays down the following rules: 1. The final *(e)* lengthens the found of the foregoing vowel; as in *can, cane; rob, robe; tun, tune*, &c. 2. The final *(e)*, in words ending in *re*, is founded before the *r* like *u*; as *maffacre, maffa-cur; lucre, lu-cur*, &c. 3. The Latin diphthongs *æ, œ*, are founded like *e*; as *Ætna, Etna; œconomy, economy*, &c.; but at the end of the words *oe* founds like *o*; as in *toe, foe*, &c. 4. Alfo the Englifh improper diphthongs, *ea, eo, eu, ue*, found only the *e* and *u*; as *tea* or *te; feoffee* or *feffee; due* or *du; true* or *tru*, &c. though fometimes *eo* and *ea* are pronounced like *ee*, as in *people, fear, near*, &c. 5. Sometimes the diphthong *(ie)* is pronounced like *e* in *cieling*, like *ee* in *field*, and, at the end of words, always like *y*, as in *lie*, &c.; and *ei* is pronounced either like *e* or *ai*, as in *deceit, reign*, &c. 6. The triphthong *eau* is pronounced like *o*, in *beau* and *jet d'eau*; and *ieu* founds like *u* in *lieu, adieu*, &c. 7. The found of *c* is hard before the vowels *a, o, u*, as in *call, cold, cup*, &c.; alfo fometimes before *h*, as in *chart, cold*, &c.; and before *l* and *r*, as in *clear, creep*, &c. It is otherwife generally foft, as in *city, cell, cyder, child*, &c. 8. In French words *ch* is founded like *fh*, as in *chagreen, machine*; and fometimes like *qu*, as in *choir*. 9. The found of *g* is hard before *a, o, u, l, r*, as in *gall, go, gum, glean, grope*; alfo before *ui*, as in *guilt, guild*, &c.; and before *h*, as in *ghoft*; fometimes before *i*, as in *gibbous, gibberifh*. It is alfo generally hard before *e*, as in *get, geld*, &c.; but foft in many words derived from the Greek and Latin, as in *geometry, genealogy, genus*, &c. Two *gg* are always hard, as in *dagger*, &c. The found of *g*, when foft, is like that of *j*. 10. In any part of a word, *ph* founds like *f*, as in *philofophy*, &c. 11. The found of *qu*, at the end of French words, is like *k*, as in *rifque*, &c. 12. The fyllables *ti* and *ci*, if followed by a vowel, found like *fi* or *fhi*; as in *fiction, logician*, &c. 13. When *cc* occurs before *i*, the firft is hard and the latter is foft; as in *flaccid*, &c. 14. The letter *p* is not pronounced at the beginning of fyllables before *f* and *t*; as in *pfalm, ptarmics*, &c. As to other peculiarities regarding the pronunciation of fingle letters, many of them have been taken notice of at the beginning of each, in the courfe of this work.

But it is not enough to know the juft pronunciation of fingle letters, but alfo of words: in order to which, the accenting of words ought to be well underftood; fince nothing is more harfh and difagreeable to the ear, than to hear a perfon fpeak or read with wrong accents. And indeed in Englifh the fame word is often

both a noun and a verb, diftinguifhed only by the accent, which is on the firft fyllable of the noun, and on the laft of the verb; as *fèrment* and *fermènt*; *rècord* and *recòrd*, &c. We are to obferve alfo, that in order to a juft expreffion of words, fome require only a fingle accent on the fyllable, as in *tòrment*, &c.; but in others it fhould be marked double, as in *anìmal*, becaufe it is pronounced as if the letter was wrote double, viz. *an-nimal*.

Mr Sheridan's Dictionary will be found extremely ufeful as a directory in acquiring the pronunciation of the Englifh language; but care muft be taken to avoid his provincial brogue, which has certainly mifled him in feveral inftances. Mr Walker's Pronouncing Dictionary, lately publifhed, will likewife deferve the ftudent's attention. It is a work of great labour and merit, and is highly ufeful. It has indeed fome faults and inaccuracies, but it is notwithftanding, in all probability, the beft of the kind.

Pronunciation is alfo ufed for the fifth and laft part of rhetoric, which confifts in varying and regulating the voice agreeably to the matter and words, fo as moft effectually to perfuade and touch the hearers. See Oratory, Part IV.

PROOF, in law and logic, is that degree of evidence which carries conviction to the mind. It differs from demonftration, which is applicable only to thofe truths of which the contrary is inconceivable. It differs likewife from probability, which produces for the moft part nothing more than opinion, while proof produces belief. See Probability.

The *proof* of crimes was anciently effected among our anceftors divers ways; viz. by duel or combat, fire, water, &c. See Duel and Ordeal.

Proof of Artillery and Small Arms, is a trial whether they ftand the quantity of powder allotted for that purpofe. The rule of the board of ordnance is, that all guns, under 24-pounders, be loaded with powder as much as their fhot weighs; that is, a brafs 24-pounder with 21 lb. a brafs 32-pounder with 26 lb. 12 oz. and a 42-pounder with 31 lb. 8 oz.; the iron 24-pounder with 18 lb. the 32-pounder with 21 lb. 8 oz. and the 42-pounder with 25 lb.

The brafs light field-pieces are proved with powder that weighs half as much as their fhot, except the 24-pounder, which is loaded with 10 lb only.

Government allows 11 bullets of lead in the pound for the proof of mufkets, and 14.5, or 29 in two pounds, for fervice; 17 in the pound for the proof of carabines, and 20 for fervice; 28 in the pound for the proof of piftols, and 34 for fervice.

When guns of a new metal, or of lighter conftruction, are proved; then, befides the common proof, they are fired 200 or 300 times, as quick as they can be, loaded with the common charge given in actual fervice. Our light 6-pounders were fired 300 times in 3 hours 27 minutes, loaded with 1 lb. 4 oz. without receiving any damage.

Proof of Powder, is in order to try its goodnefs and ftrength. See Gunpowder.

Proof of Cannon, is made to afcertain their being well caft, their having no cavities in their metal, and, in a word, their being fit to refift the effort of their charge of powder. In making this proof, the piece is laid upon the ground, fupported only by a piece of wood in the middle, of about 5 or 6 inches thick; to raife the muzzle a little; and then the piece is fired againft a folid butt of earth. Proof.

Tools ufed in the Proof of Cannon are as follow:

Searcher, an iron focket with branches, from 4 to 8 in number, bending outwards a little, with fmall points at their ends: to this focket is fixed a wooden handle, from 8 to 12 feet long, and $1\frac{1}{2}$ inch in diameter. This fearcher is introduced into the gun after each firing, and turned gently round to difcover the cavities within: if any are found, they are marked on the outfide with chalk; and then the

Searcher with one point is introduced: about which point a mixture of wax and tallow is put, to take the impreffion of the holes; and if any are found of one-fourth of an inch deep, or of any confiderable length, the gun is rejected as unferviceable to the government.

Reliever, is an iron ring fixed to a handle, by means of a focket, fo as to be at right angles; it ferves to difengage the firft fearcher, when any of its points are retained in a hole, and cannot otherwife be got out. When guns are rejected by the proof-mafters, they order them to be marked X thus, which the contractors generally alter *WP* thus; and after fuch alteration, difpofe of them to foreign powers for Woolwich proof.

The moft curious inftrument for finding the principal defects in pieces of artillery, was lately invented by lieutenant-general Defaguliers, of the royal regiment of artillery. This inftrument, grounded on the trueft mechanical principles, is no fooner introduced into the hollow cylinder of the gun, than it difcovers its defects, and more particularly that of the piece not being truly bored; which is a very important one, and to which moft of the difafters happening to pieces of artillery are in a great meafure to be imputed; for, when a gun is not truly bored, the moft expert artillerift will not be able to make a good fhot.

Proof of Mortars and Howitzers, is made to afcertain their being well caft, and of ftrength to refift the effort of their charge. For this purpofe the mortar or howitzer is placed upon the ground, with fome part of their trunnions or breech funk below the furface, and refting on wooden billets, at an elevation of about 70 degrees.

The mirror is generally the only inftrument to difcover the defects in mortars and howitzers. In order to ufe it, the fun muft fhine; the breech muft be placed towards the fun, and the glafs over-againft the mouth of the piece: it illuminates the bore and chamber fufficiently to difcover the flaws in it.

Proof of Foreign Brafs-Artillery. 1ft, The Pruffians. Their battering-train and garrifon artillery are proved with a quantity of powder equal to $\frac{1}{2}$ the weight of the fhot, and fired 75 rounds as faft as in real fervice; that is, 2 or 3 rounds in a minute. Their light field-train, from a 12-pounder upwards, are proved with a quantity of powder = 1-3d of the weight of the fhot, and fired 150 rounds, at 3 or 4 rounds in a minute. From a 12-pounder downwards, are proved with a quantity of powder = 1-5th of the fhot's weight, and fired 300 rounds, at 5 or 6 rounds each minute, properly fpunged and loaded. Their mortars are proved with the chambers full of powder, and the fhells loaded. Three rounds are fired as quick as poffible.

2d, The Dutch prove all their artillery by firing each

Proof, Propagation.

each piece 5 times; the two first rounds with a quantity of powder = 2-3ds of the weight of the shot; and the three last rounds with a quantity of powder = ½ the weight of the shot.

3d, The French the same as the Dutch.

Proof, in brandy and other spirituous liquors, is a little white lather which appears on the top of the liquor when poured into a glass. This lather, as it diminishes, forms itself into a circle called by the French the *chapelet*, and by the English the *bead* or *bubble*.

Nichols's Life of Hogarth.

Proofs *of Prints*, were anciently a few impressions taken off in the course of an engraver's process. He proved a plate in different states, that he might ascertain how far his labours had been successful, and when they were complete. The excellence of such early impressions, worked with care, and under the artist's eye, occasioning them to be greedily sought after, and liberally paid for, it has been customary among our modern printsellers to take off a number of them, amounting, perhaps to hundreds, from every plate of considerable value; and yet their want of rareness has by no means abated their price. On retouching a plate, it has been also usual, among the same conscientious fraternity, to cover the inscription, which was immediately added after the first proofs were obtained, with slips of paper, that a number of secondary proofs might also be created.

Proof, in the sugar trade. See Sugar.

Proofs, in printing. See Printing, p. 524, col. 2.

PROPAGATION, the act of multiplying the kind. See Generation.

Propagation *of Plants*. The most natural and the most universal way of propagating plants is by seeds. See Plants, and Natural History, p. 654. But they may also be propagated by *sets*, *pieces*, or *cuttings*, taken from the parent plant. Willows are very easily propagated by sets: such as rise to be considerable timber trees being raised from sets 7 or 8 feet long, sharpened at their larger ends, which are thrust into the ground by the sides of ditches, on the banks of rivers, or in any moist soil. The sallow trees are raised from sets only 3 feet long. The plane tree, mint, &c. may be propagated in the same way. In providing the slips, sprigs, or cuttings, however, care must be taken to cut off such branches as have knots or joints 2 or 3 inches beneath them; small top sprigs of 2 or 3 years growth are the best for this operation. Plants are also propagated by parting their roots, each part of which, properly managed, sends out fresh roots. Another mode of propagating plants is by layering or laying the tops of the branches in the ground.

The method of layering is this: Dig a ring-trench round the stool, of a depth suitable to the nature of the plant; and having pitched upon the shoots to be layered, bend them to the bottom of the trench (either with or without plashing, as may be found most convenient), and there *peg* them fast; or, putting some mould upon them, *tread* them hard enough to prevent their springing up again—fill in the mould—place the top of the layer in an upright posture, treading the mould hard behind it; and cut it carefully off above the first, second, or third eye. Plants are also propagated by their bulbs.

The number of vegetables that may be propagated from an individual is very remarkable, especially in the most minute plants. The annual product of one seed even of the common mallow has been found to be no less than 200,000; but it has been since proved, by a strict examination into the more minute parts of the vegetable world, that so despised a plant as the common wall moss produces a much more numerous offspring. In one of the little heads of this plant there have been counted 13824 seeds. Now allotting to a root of this plant eight branches, and to each branch six heads, which appears to be a very moderate computation, the produce of one seed is $6 \times 13824 = 82944$; and 8×82944, gives 663,552 seeds as the annual produce of one seed, and that so small that 13824 of them are contained in a capsule, whose length is but one ninth of an inch, its diameter but one 23d of an inch, and its weight but the 13th part of a grain.

For the propagation or culture of particular plants, see Agriculture, Part II. sect. 3. p. 288. and Husbandry.

PROPER, something natural and essentially belonging to any thing.

PROPERTIUS (Sextus Aurelius), a celebrated Latin poet, born at Mevania, a city of Umbria, now called *Bevagna*, in the duchy of Spoletto. He went to Rome after the death of his father, a Roman knight, who had been put to death by order of Augustus, for having followed Antony's party during the triumvirate. Propertius in a short time acquired great reputation by his wit and abilities, and had a considerable share in the esteem of Mæcenas and Cornelius Gallus. He had also Ovid, Tibullus, Bassus, and the other ingenious men of his time, for his friends. He died at Rome 19 B. C. He is printed with almost all the editions of Tibullus and Catullus: but the best edition of him is that which was given separately by Janus Brouckhusius at Amsterdam, 1702, in 4to, and again in 1714, 4to. *cum curis secundis ejusdem.* We have four books of his Elegies or Amours with a lady called *Hostia*, or *Hostilia*, to whom he gave the name of *Cynthia*.

PROPERTY, in a general sense, is a particular virtue or quality which nature has bestowed on some things exclusive of all others: thus, colour is a property of light; extension, figure, divisibility, and impenetrability, are properties of body.

Definition.

Property, in law, is described to be the highest right which a person has or can have to any thing.

The original foundation of right to property not generally considered.

There is nothing which so generally strikes the imagination, and engages the affections of mankind, as the right of property; or that sole and despotic dominion which one man claims and exercises over certain external things of the world, in total exclusion of the right of any other individual in the universe. And yet there are very few that will give themselves the trouble to consider the original and foundation of this right. Pleased as we are with the possession, we seem afraid to look back to the means by which it was acquired, as if fearful of some defect in our title; or at best we rest satisfied with the decision of the laws in our favour, without examining the reason or authority upon which those laws have been built. We think it enough that our title is derived by the grant of the former proprietor, by descent from our ancestors, or by the last will and testament of the dying owner: not caring to reflect, that (accurately and strictly speaking) there is no foundation in nature or in natural law, why a set of words upon parchment should convey the dominion of land; why the son should have a right to exclude his fellow-creatures from a de-

a determinate ſpot of ground, becauſe his father had done ſo before him; or why the occupier of a particular field or of a jewel, when lying on his death-bed and no longer able to maintain poſſeſſion, ſhould be entitled to tell the reſt of the world which of them ſhould enjoy it after him. Theſe inquiries, it muſt be owned, would be uſeleſs and even troubleſome in common life. It is well if the maſs of mankind will obey the laws when made, without ſcrutinizing too nicely into the reaſons of making them. But when law is to be conſidered not only as a matter of practice, but alſo as a rational ſcience, it cannot be improper or uſeleſs to examine more deeply the rudiments and grounds of theſe poſitive conſtitutions of ſociety.

In the beginning of the world, we are informed by holy writ, that the all-bountiful Creator gave to man "dominion over all the earth; and over the fiſh of the "ſea, and over the fowl of the air, and over every li- "ving thing that moveth upon the earth." This is the only true and ſolid foundation of man's dominion over external things, whatever airy metaphyſical notions may have been ſtarted by fanciful writers upon this ſubject. The earth, therefore, and all things therein, are the general property of all mankind, excluſive of other beings, from the immediate gift of the Creator. And, while the earth continued thinly inhabited, it is reaſonable to ſuppoſe, that all was in common among them, and that every one took from the public ſtock to his own uſe ſuch things as his immediate neceſſities required.

4 Theſe general notions of property were then ſufficient to anſwer all the purpoſes of human life; and might perhaps ſtill have anſwered them, had it been poſſible for mankind to have remained in a ſtate of primæval ſimplicity: as may be collected from the manners of many American nations, when firſt diſcovered by the Europeans; and from the ancient method of living among the firſt Europeans themſelves, if we may credit either the memorials of them preſerved in the golden age of the poets, or the uniform accounts given by hiſtorians of thoſe times wherein *erant omnia communia et indiviſa omnibus, veluti unum cunctis patrimonium eſſet*. Not that this communion of goods ſeems ever to have been applicable, even in the earlieſt ages, to aught but the *ſubſtance* of the thing; nor could it be extended to the *uſe* of it. For, by the law of nature and reaſon, he who firſt began to uſe it, acquired therein a kind of tranſient property, that laſted ſo long as he was uſing it, and no longer: or, to ſpeak with greater preciſion, the *right* of poſſeſſion continued for the ſame time only that the *act* of poſſeſſion laſted. Thus the ground was in common, and no part of it was the permanent property of any man in particular; yet whoever was in the occupation of any determinate ſpot of it, for reſt, for ſhade, or the like, acquired for the time a ſort of ownerſhip, from which it would have been unjuſt, and contrary to the law of nature, to have driven him by force; but the inſtant that he quitted the uſe or occupation of it, another might ſeize it without injuſtice. Thus alſo a vine or other tree might be ſaid to be in common, as all were equally entitled to its produce; and yet any private individual might gain the ſole property of the fruit, which he had gathered for his own repaſt. A doctrine well illuſtrated by Cicero, who compares the world to a great theatre, which is common to the public, and yet the place which any man has taken is for the time his own.

Property.

5 Riſe of permanent property in various things.

But when mankind increaſed in number, craft, and ambition, it became neceſſary to entertain conceptions of more permanent dominion; and to appropriate to individuals, not the immediate *uſe* only, but the very *ſubſtance* of the thing to be uſed: otherwiſe innumerable tumults muſt have ariſen, and the good order of the world been continually broken and diſturbed, while a variety of perſons were ſtriving who ſhould get the firſt occupation of the ſame thing, or diſputing which of them had actually gained it. As human life alſo grew more and more refined, abundance of conveniencies were deviſed to render it more eaſy, commodious, and agreeable; as habitations for ſhelter and ſafety, and raiment for warmth and decency. But no man would be at the trouble to provide either, ſo long as he had only an uſufructuary property in them, which was to ceaſe the inſtant that he quitted poſſeſſion;—if, as ſoon as he walked out of his tent, or pulled off his garment, the next ſtranger who came by would have a right to inhabit the one and to wear the other. In caſe of habitations in particular, it was natural to obſerve, that even the brute creation, to whom every thing elſe was in common, maintained a permanent property in their dwellings, eſpecially for the protection of their young; that the birds of the air had neſts, and the beaſts of the field had caverns, the invaſion of which they eſteemed a very flagrant injuſtice, and would ſacrifice their lives to preſerve them. Hence a property was ſoon eſtabliſhed in every man's houſe and home-ſtall; which ſeem to have been originally mere temporary huts or moveable cabins, ſuited to the deſign of Providence for more ſpeedily peopling the earth, and ſuited to the wandering life of their owners, before any extenſive property in the ſoil or ground was eſtabliſhed. And there can be no doubt, but that moveables of every kind became ſooner appropriated than the permanent ſubſtantial ſoil: partly becauſe they were more ſuſceptible of a long occupancy, which might be continued for months together without any ſenſible interruption, and at length by uſage ripen into an eſtabliſhed right; but principally becauſe few of them could be fit for uſe, till improved and meliorated by the bodily labour of the occupant; which bodily labour, beſtowed upon any ſubject which before lay in common to all men, is univerſally allowed to give the faireſt and moſt reaſonable title to an excluſive property therein.

6 In food and other neceſſary articles.

The article of food was a more immediate call, and therefore a more early conſideration. Such as were not contented with the ſpontaneous product of the earth ſought for a more ſolid refreſhment in the fleſh of beaſts, which they obtained by hunting. But the frequent diſappointments incident to that method of proviſion induced them to gather together ſuch animals as were of a more tame and ſequacious nature; and to eſtabliſh a permanent property in their flocks and herds, in order to ſuſtain themſelves in a leſs precarious manner, partly by the milk of their dams, and partly by the fleſh of the young. The ſupport of theſe their cattle made the article of *water* alſo a very important point. And therefore the book of Geneſis (the moſt venerable monument of antiquity, conſidered merely with a view to hiſtory) will furniſh us with frequent inſtances of violent contentions concerning wells; the excluſive property of which appears to have been eſtabliſhed in the firſt digger or occupant, even in ſuch places where the ground and herbage

7 Nature of patriarchal property.

remained

Property.

remained yet in common. Thus we find Abraham, who was but a ſojourner, aſſerting his right to a well in the country of Abimelech, and exacting an oath for his ſecurity, "becauſe he had digged that well." And Iſaac, about 90 years afterwards, reclaimed this his father's property; and, after much contention with the Philiſtines, was ſuffered to enjoy it in peace.

All this while the ſoil and paſture of the earth remained ſtill in common as before, and open to every occupant: except perhaps in the neighbourhood of towns, where the neceſſity of a ſole and excluſive property in lands (for the ſake of agriculture) was earlier felt, and therefore more readily complied with. Otherwiſe, when the multitude of men and cattle had conſumed every convenience on one ſpot of ground, it was deemed a natural right to ſeize upon and occupy ſuch other lands as would more eaſily ſupply their neceſſities. This practice is ſtill retained among the wild and uncultivated nations that have never been formed into civil ſtates, like the Tartars and others in the eaſt; where the climate itſelf, and the boundleſs extent of their territory, conſpire to retain them ſtill in the ſame ſavage ſtate of vagrant liberty, which was univerſal in the earlieſt ages, and which Tacitus informs us continued among the Germans till the decline of the Roman empire. We have alſo a ſtriking example of the ſame kind in the hiſtory of Abraham and his nephew Lot. When their joint ſubſtance became ſo great, that paſture and other conveniencies grew ſcarce, the natural conſequence was, that a ſtrife aroſe between their ſervants; ſo that it was no longer practicable to dwell together. This contention Abraham endeavoured to compoſe: "Let there be no ſtrife, I pray thee, between thee and me. Is not the whole land before thee? Separate thyſelf, I pray thee, from me: If thou wilt take the left hand, then I will go to the right; or if thou depart to the right hand, then I will go to the left." This plainly implies an acknowledged right, in either, to occupy whatever ground he pleaſed, that was not pre-occupied by other tribes. "And Lot lifted up his eyes, and beheld all the plain of Jordan, that it was well watered everywhere, even as the garden of the Lord. Then Lot choſe him all the plain of Jordan, and journeyed eaſt; and Abraham dwelt in the land of Canaan."

Upon the ſame principle was founded the right of migration, or ſending colonies to find out new habitations, when the mother-country was overcharged with inhabitants; which was practiſed as well by the Phœnicians and Greeks, as the Germans, Scythians, and other northern people. And, ſo long as it was confined to the ſtocking and cultivation of deſert uninhabited countries, it kept ſtrictly within the limits of the law of nature.

8
Neceſſity of property and of laws reſpecting it.

But as the world by degrees grew more populous, it daily became more difficult to find out new ſpots to inhabit, without encroaching upon former occupants; and by conſtantly occupying the ſame individual ſpot, the fruits of the earth were conſumed, and its ſpontaneous produce deſtroyed, without any proviſion for a future ſupply or ſucceſſion. It therefore became neceſſary to purſue ſome regular method of providing a conſtant ſubſiſtence; and this neceſſity produced, or at leaſt promoted and encouraged, the art of agriculture. And the art of agriculture, by a regular connection and conſequence, introduced and eſtabliſhed the idea of a more permanent property in the ſoil than had hitherto been received and adopted. It was clear that the earth would not produce her fruits in ſufficient quantities without the aſſiſtance of tillage; but who would be at the pains of tilling it, if another might watch an opportunity to ſeize upon and enjoy the product of his induſtry, art, and labour? Had not therefore a ſeparate property in lands, as well as moveables, been veſted in ſome individuals, the world muſt have continued a foreſt, and men have been mere animals of prey; which, according to ſome philoſophers, is the genuine ſtate of nature. Whereas now (ſo graciouſly has Providence interwoven our duty and our happineſs together) the reſult of this very neceſſity has been the ennobling of the human ſpecies, by giving it opportunities of improving in *rational* faculties, as well as of exerting its *natural*. Neceſſity begat property: and in order to inſure that property, recourſe was had to civil ſociety, which brought along with it a long train of inſeparable concomitants; ſtates, government, laws, puniſhments, and the public exerciſe of religious duties. Thus connected together, it was found that a part only of ſociety was ſufficient to provide, by their manual labour, for the neceſſary ſubſiſtence of all; and leiſure was given to others to cultivate the human mind, to invent uſeful arts, and to lay the foundations of ſcience.

9
Property acquired firſt by occupancy.

The only queſtion remaining is, How this property became actually veſted; or what it is that gave a man an excluſive right to retain in a permanent manner that ſpecific land which before belonged generally to every body, but particularly to nobody? And as we before obſerved, that *occupancy* gave the right to the temporary *uſe* of the ſoil; ſo it is agreed upon all hands, that occupancy gave alſo the original right to the permanent property in the *ſubſtance* of the earth itſelf, which excludes every one elſe but the owner from the uſe of it. There is indeed ſome difference among the writers on natural law, concerning the reaſon why occupancy ſhould convey this right, and inveſt one with this abſolute property: Grotius and Puffendorf inſiſting, that this right of occupancy is founded upon a tacit and implied aſſent of all mankind, that the firſt occupant ſhould become the owner; and Barbeyrac, Titius, Mr Locke, and others, holding, that there is no ſuch implied aſſent, neither is it neceſſary that there ſhould be; for that the very act of occupancy, alone, being a degree of bodily labour, is from a principle of natural juſtice, without any conſent or compact, ſufficient of itſelf to gain a title. A diſpute that favours too much of nice and ſcholaſtic refinement. However, both ſides agree in this, that occupancy is the thing by which the title was in fact originally gained; every man ſeizing to his own continued uſe ſuch ſpots of ground as he found moſt agreeable to his own convenience, provided he found them unoccupied by any one elſe.

10
By what means preſerved or loſt.

Property, both in lands and moveables, being thus originally acquired by the firſt taker, which taking amounts to a declaration, that he intends to appropriate the thing to his own uſe, it remains in him, by the principle of univerſal law, till ſuch time as he does ſome other act which ſhows an intention to abandon it; for then it becomes, naturally ſpeaking, *publici juris* once more, and is liable to be again appropria-

ted by the next occupant. So if one is possessed of a jewel, and casts it into the sea or a public highway, this is such an express dereliction, that a property will be vested in the first fortunate finder that shall seize it to his own use. But if he hides it privately in the earth, or other secret place, and it is discovered, the finder acquires no property therein; for the owner hath not by this act declared any intention to abandon it, but rather the contrary: and if he loses or drops it by accident, it cannot be collected from thence that he designed to quit the possession; and therefore in such case the property still remains in the loser, who may claim it again of the finder. And this, we may remember, is the doctrine of the English law with relation to *Treasure-Trove*.

But this method, of one man's abandoning his property, and another seizing the vacant possession, however well founded in theory, could not long subsist in fact. It was calculated merely for the rudiments of civil society, and necessarily ceased among the complicated interests and artificial refinements of polite and established governments. In these it was found, that what became inconvenient or useless to one man, was highly convenient and useful to another; who was ready to give in exchange for it some equivalent that was equally desirable to the former proprietor. This mutual convenience introduced commercial traffic, and the reciprocal transfer of property by sale, grant, or conveyance: which may be considered either as a continuance of the original possession which the first occupant had; or as an abandoning of the thing by the present owner, and an immediate successive occupancy of the same by the new proprietor. The voluntary dereliction of the owner, and delivering the possession to another individual, amount to a transfer of the property; the proprietor declaring his intention no longer to occupy the thing himself, but that his own right of occupancy shall be vested in the new acquirer. Or, taken in the other light, if I agree to part with an acre of my land to Titius, the deed of conveyance is an evidence of my intending to abandon the property; and Titius, being the only or first man acquainted with such my intention, immediatly steps in and seizes the vacant possession: thus the consent expressed by the conveyance gives Titius a good right against me; and possession or occupancy confirms that right against all the world besides.

11
w it
s on the
th of
occu-
t.

The most universal and effectual way of abandoning property is by the death of the occupant: when, both the actual possession and intention of keeping possession ceasing, the property, which is founded upon such possession and intention, ought also to cease of course. For, naturally speaking, the instant a man ceases to be, he ceases to have any dominion: else, if he had a right to dispose of his acquisitions one moment beyond his life, he would also have a right to direct their disposal for a million of ages after him; which would be highly absurd and inconvenient (A). All property must therefore cease upon death, considering men as absolute individuals, and unconnected with civil society: for then, by the principles before established, the next immediate occupant would acquire a right in all that the deceased possessed. But as, under civilized governments, which are calculated for the peace of mankind, such a constitution would be productive of endless disturbances, the universal law of almost every nation (which is a kind of secondary law of nature) has either given the dying person a power of continuing his property, by disposing of his possessions by will; or, in case he neglects to dispose of it, or is not permitted to make any disposition at all, the municipal law of the country then steps in, and declares who shall be the successor, representative, or heir of the deceased; that is, who alone shall have a right to enter upon this vacant possession, in order to avoid that confusion which its becoming again common would occasion. And farther, in case no testament be permitted by the law, or none be made, and no heir can be found so qualified as the law requires, still, to prevent the robust title of *occupancy* from again taking place, the doctrine of escheats is adopted in almost every country; whereby the sovereign of the state, and those who claim under his authority, are the ultimate heirs, and succeed to those inheritances to which no other title can be formed.

12
Of the right of inheritance.

The right of inheritance, or descent to the children and relations of the deceased, seems to have been allowed much earlier than the right of devising by testament. We are apt to conceive at the first view that it has nature on its side; yet we often mistake for nature what we find established by long and inveterate custom. It is certainly a wise and effectual, but clearly a political, establishment; since the permanent right of property, vested in the ancestor himself, was no *natural*, but merely a *civil*, right. It is true, that the transmission of one's possessions to posterity has an evident tendency to make a man a good citizen and a useful member of society: it sets the passions on the side of duty, and prompts a man to deserve well of the public, when he is sure that the reward of his services will not die with himself, but be transmitted to those with whom he is connected by the dearest and most tender affections. Yet, reasonable as this foundation of the right of inheritance may seem, it is probable that its immediate original arose not from speculations altogether so delicate and refined, and, if not from fortuitous circumstances, at least from a plainer and more simple principle. A man's children or nearest relations are usually about him on his death-bed, and are the earliest witnesses of his decease. They became therefore generally the next immediate occupants, till at length in process of time this frequent usage ripened into general law. And therefore also in the earliest ages, on failure of children, a man's servants born under his roof were allowed to be his heirs; being immediately on the spot when he died. For we find the old patriarch Abraham expresly declaring, that "since God had given him no seed, his steward Eliezer, one born in his house, was his heir."

While property continued only for life, testaments were

(A) This right, inconvenient as it certainly is, the law of Scotland gives to every man over his *real* estate, by authorising him to entail it on his heirs for ever. See Law, clxxx. 9, 10, 11. and Tailzie.

Property.

13 Last wills or testaments

were useless and unknown; and when it became inheritable, the inheritance was long indefeasible, and the children or heirs at law were incapable of exclusion by will. Till at length it was found, that so strict a rule of inheritance made heirs disobedient and headstrong, defrauded creditors of their just debts, and prevented many provident fathers from dividing or charging their estates as the exigence of their families required. This introduced pretty generally the right of disposing of one's property, or a part of it, by *testament*; that is, by written or oral instructions properly *witnessed* and authenticated, according to the *pleasure* of the deceased; which we therefore emphatically style his *will*. This was established in some countries much later than in others. In England, till modern times, a man could only dispose of one-third of his moveables from his wife and children; and, in general, no will was permitted of lands till the reign of Henry VIII. and then only of a certain portion; for it was not till after the Restoration that the power of devising real property became so universal as at present.

14 Are creatures of the civil or municipal laws. *Blackst. Comment.*

Wills, therefore, and testaments, rights of inheritance, and successions, are all of them creatures of the civil or municipal laws, and accordingly are in all respects regulated by them; every distinct country having different ceremonies and requisites to make a testament completely valid; neither does any thing vary more than the right of inheritance under different national establishments. In England particularly, this diversity is carried to such a length, as if it had been meant to point out the power of the laws in regulating the succession to property, and how futile every claim must be that has not its foundation in the positive rules of the state. In personal estates, the father may succeed to his children; in landed property, he never can be their immediate heir by any the remotest possibility: in general, only the eldest son, in some places only the youngest, in others all the sons together, have a right to succeed to the inheritance: In real estates, males are preferred to females, and the eldest male will usually exclude the rest; in the division of personal estates, the females of equal degree are admitted together with the males, and no right of primogeniture is allowed.

15 Scruples respecting heritable property removed.

This one consideration may help to remove the scruples of many well-meaning persons, who set up a mistaken conscience in opposition to the rules of law. If a man disinherits his son, by a will duly executed, and leaves his estate to a stranger, there are many who consider this proceeding as contrary to natural justice; while others so scrupulously adhere to the supposed intention of the dead, that if a will of lands be attested by only *two* witnesses instead of *three*, which the law requires, they are apt to imagine that the heir is bound in conscience to relinquish his title to the devisee. But both of them certainly proceed upon very erroneous principles: as if, on the one hand, the son had by nature a right to succeed to his father's lands; or as if, on the other hand, the owner was by nature entitled to direct the succession of his property after his own decease. Whereas the law of nature suggests, that on the death of the possessor, the estate should again become common, and be open to the next occupant, unless otherwise ordered, for the sake of civil peace, by the positive law of society. The positive law of society, which is with us the municipal laws of England and Scotland, directs it to vest in such person as the last proprietor shall by will, attended with certain requisites, appoint; and, in defect of such appointment, to go to some particular person, who, from the result of certain local constitutions, appears to be the heir at law. Hence it follows, that, where the appointment is regularly made, there cannot be a shadow of right in any one but the person appointed: and, where the necessary requisites are omitted, the right of the heir is equally strong and built upon as solid a foundation, as the right of the devisee would have been, supposing such requisites were observed.

16 Of thin[gs] that are still in c[om]mon.

But, after all, there are some few things, which, notwithstanding the general introduction and continuance of property, must still unavoidably remain in common; being such wherein nothing but an usufructuary property is capable of being had: and therefore they still belong to the first occupant, during the time he holds possession of them, and no longer. Such (among others) are the elements of light, air, and water; which a man may occupy by means of his windows, his gardens, his mills, and other conveniences: such also are the generality of those animals which are said to be *feræ naturæ*, or of a wild and untameable disposition; which any man may seize upon and keep for his own use or pleasure. All these things, so long as they remain in possession, every man has a right to enjoy without disturbance; but if once they escape from his custody, or he voluntarily abandons the use of them, they return to the common stock, and any other man has an equal right to seize and enjoy them afterwards.

17 Of simil[ar] things which h[ave] been ap[pro]priated.

Again, there are other things in which a permanent property may subsist, not only as to the temporary use, but also the solid substance; and which yet would be frequently found without a proprietor, had not the wisdom of the law provided a remedy to obviate this inconvenience. Such are forests and other waste grounds, which were omitted to be appropriated in the general distribution of lands: such also are wrecks, estrays, and that species of wild animals, which the arbitrary constitutions of positive law have distinguished from the rest by the well-known appellation of *game*. With regard to these and some others, as disturbances and quarrels would frequently arise among individuals contending about the acquisition of this species of property by first occupancy, the law has therefore wisely cut up the root of dissension, by vesting the things themselves in the sovereign of the state; or else in his representatives appointed and authorised by him, being usually the lords of manors. And thus our legislature has universally promoted the grand ends of civil society, the peace and security of individuals, by steadily pursuing that wise and orderly maxim, of assigning to every thing capable of ownership a legal and determinate owner.

18 The rea[soning] of those w[ho] contend [for] an equa[li]zation o[f] property.

In this age of paradox and innovation, much has been said of *liberty* and *equality*; and some few have contended for an equalization of property. One of the wildest declaimers on this subject, who is for abolishing property altogether, has (inadvertently we suppose) given a complete confutation, not only of his own arguments, but also of the arguments of all who have

Property, Prophecy.

have written, or, we think, can write, on the ſame ſide of the queſtion. After labouring to prove that it is groſs injuſtice in any man to retain more than is abſolutely neceſſary to ſupply him with food, clothes, and ſhelter, this zealous reformer ſtates an objection to his theory, ariſing from the well-known allurements of ſloth, which, if the accumulation of property were not permitted, would baniſh induſtry from the whole world. The objection he urges fairly, and anſwers it thus: "It may be obſerved, that the equality for which we are pleading is an equality that would ſucceed to a ſtate of great intellectual improvement. So bold a revolution cannot take place in human affairs, till the general mind has been highly cultivated. The preſent age of mankind is greatly enlightened; but it is to be feared is not yet enlightened enough. Haſty and undigeſted tumults may take place under the idea of an equalization of property; but it is only a calm and clear conviction of juſtice, of juſtice mutually to be rendered and received, of happineſs to be produced by the *deſertion of our moſt rooted habits*, that can introduce an invariable ſyſtem of this ſort. Attempts without this preparation will be productive only of confuſion. Their effect will be momentary, and a new and more barbarous inequality will ſucceed. Each man with unaltered appetite will watch his opportunity to gratify his love of power, or his love of diſtinction, by uſurping on his inattentive neighbours."

19
The effect of ignorance of human nature.

Theſe are juſt obſervations, and ſuch as we have often made to ourſelves on the various propoſed reformations of government. The illumination which the author requires before he would introduce his abolition of property, would conſtitute men more than angels; for to be under the influence of no paſſion or appetite, and to be guided in every action by unmixed benevolence and pure intellect, is a degree of perfection which we can attribute to no being inferior to God. But it is the object of the greater part of this writer's book to prove that all men muſt arrive at ſuch perfection before his ideal republic can contribute to their happineſs; and therefore every one who is conſcious of being at any time ſwayed by paſſion, and who feels that he is more attached to his wife or children than to ſtrangers, will look without envy to the preſent inequalities of property and power, if he be an intelligent diſciple of Mr Godwin.

Literary PROPERTY, See COPY-RIGHT.

1
Definition.

PROPHECY is a word derived from προφητεια, and in its original import ſignifies the prediction of future events.

2
Prophecy proves a ſupernatural communion with the Deity

As God alone can perceive with certainty the future actions of free agents, and the remote conſequences of thoſe laws of nature which he himſelf eſtabliſhed, prophecy, when clearly fulfilled, affords the moſt convincing evidence of an intimate and ſupernatural communion between God and the perſon who uttered the prediction. Together with the power of working miracles, it is indeed the only evidence which can be given of ſuch a communion. Hence among the profeſſors of every religious ſyſtem, except that which is called the religion of nature, there have been numberleſs pretenders to the gift of prophecy. The Pagan nations of antiquity had their oracles, augurs, and ſoothſayers. Modern idolaters have their necromancers and diviners; and the

3
The profeſſors of all religions have pretended to

Jews, Chriſtians, and Mahometans, have their ſeers and prophets.

The ill-founded pretenſions of paganiſm, ancient and modern, have been expoſed under various articles of this work. (See DIVINATION, MAGIC, NECROMANCY, and MYTHOLOGY). And the claims of the Arabian impoſtor are examined under the articles ALCORAN and MAHOMETANISM; ſo that at preſent we have only to conſider the uſe, intent, and truth, of the Jewiſh and Chriſtian prophecies.

4
The word in Scripture has various meanings.

Previous to our entering on this inveſtigation, it may be proper to obſerve, that in the Scriptures of the Old and New Teſtaments, the ſignification of the word prophecy is not always confined to the foretelling of future events. In ſeveral inſtances it is of the ſame import with preaching, and denotes the faculty of illuſtrating and applying to preſent practical purpoſes the doctrines of prior revelation. Thus in Nehemiah it is ſaid, "Thou haſt appointed prophets to preach*;" and whoever ſpeaketh unto men to edification, and exhortation, and comfort, is by St Paul called a *prophet*‡. Hence it was that there were ſchools of prophets in Iſrael, where young men were inſtructed in the truths of religion, and fitted to exhort and comfort the people.

* Ch. vi. v. 7.

‡ 1 Cor. ch. xiv. v. 3.

In this article, however, it is chiefly of importance to confine ourſelves to that kind of prophecy which, in declaring truths either paſt, preſent, or future, required the immediate inſpiration of God.

5
Science and religion gradually acquired.

Every one who looks into the hiſtory of the world muſt obſerve, that the minds of men have from the beginning been gradually opened by a train of events ſtill improving upon, and adding light to each other; as that of each individual is, by proceeding from the firſt elements and ſeeds of ſcience, to more enlarged views, and a ſtill higher growth. Mankind neither are nor ever have been capable of entering into the depths of knowledge at once; of receiving a whole ſyſtem of natural or moral truths together; but muſt be let into them by degrees, and have them communicated by little and little, as they are able to bear it. That this is the caſe with reſpect to human ſcience, is a fact which cannot be queſtioned; and there is as little room to queſtion it with reſpect to the progreſs of religious knowledge among men, either taken collectively or in each individual. Why the caſe is thus in both, why all are not adult at once in body and mind, is a queſtion which the religion of nature is equally called upon with revelation to anſwer. The fact may not be eaſily accounted for, but the reality of it is incontrovertible.

6
The revelation of the Old Teſtament gradual.

Accordingly, the great object of the ſeveral revelations recorded in the Old Teſtament was evidently to keep alive a ſenſe of religion in the minds of men, and to train them by degrees for the reception of thoſe ſimple but ſublime truths by which they were to be ſaved. The notions which the early deſcendants of Adam entertained of the Supreme Being, and of the relation in which they ſtood to him, were probably very groſs; and we ſee them gradually refined by a ſeries of revelations or prophecies, each in ſucceſſion more explicit than that by which it was preceded, till the advent of Him who was the way, the truth, and the life, and who brought to light life and immortality.

When a revelation was made of any important truth, the grounds of which the mind of man has not facul-

ties to comprehend, that revelation, though undoubtedly a prophecy, must have been so far from confirming the truth of revealed religion in general, that it could not gain credit itself, but by some extrinsic evidence that it came indeed from God. Hence we find Moses, after it was revealed to him from the burning bush that he should deliver his countrymen from Egyptian bondage, replying, "Behold, they will not believe me, nor hearken to my voice; for they will say, the Lord hath not appeared unto thee." This revelation certainly constituted him a prophet to Israel; and there cannot be a doubt but that he perfectly knew the divine source from which he received it: but he very naturally and reasonably concluded, that the children of Israel would not believe that the Lord had appeared to him, unless he could give them some other proof of this preternatural appearance than his own simple affirmation of its reality. This proof he was immediately enabled to give, by having conferred upon him the power of working miracles in confirmation of his prophecy. Again, when Gideon was called to the deliverance of Israel, the angel of the Lord came and said unto him, "The Lord is with thee, thou mighty man of valour: go in this thy might, and thou shalt save Israel from the hand of the Midianites. Have not I sent thee?" Here was a prophecy delivered by the angel of the Lord to encourage Gideon's undertaking: but he, being probably afraid of some illusion of sense or imagination, demanded a sign that he was really an angel who talked with him. A sign is accordingly given him, a miraculous sign, with which he is satisfied, and undertakes the work appointed him.

7 Prophecy always accompanied by miracles.

8 And of itself can be no proof of a revelation.

From these and many similar transactions recorded in the Old Testament, it appears that prophecy was never intended as evidence of an original revelation. It is indeed, by its very nature, totally unfit for such a purpose; because it is impossible, without some extrinsic proof of its divine origin, to know whether any prophecy be true or false, till the era arrive at which it ought to be fulfilled. When it is fulfilled, it affords complete evidence that he who uttered it spake by the spirit of God, and that the doctrines which he taught of a religious nature, were all either dictated by the same spirit, or at least are true, and calculated to direct mankind in the way of their duty.

9 It was intended to preserve a sense of religion among men.

The prophecies vouchsafed to the patriarchs in the most early periods of the world, were all intended to keep alive in their minds a sense of religion, and to direct their views to the future completion of that first and greatest prophecy which was made to Adam immediately on his fall: but in order to secure credit to those prophecies themselves, they were always accompanied by some miraculous sign that they were indeed given by the God of truth, and not the delusions of fanaticism or hypocrisy. Prophecy, in the proper sense of the word, commenced with the fall; and the first instance of it is implied in the sentence denounced upon the original deceiver of mankind; "I will put enmity between thee and the woman, and between thy seed and her seed: It shall bruise thy head, and thou shalt bruise his heel."

10 Probable effects of the first prophecy on our first parents.

This prophecy, though one of the most important that ever was delivered, when considered by itself, is exceedingly obscure. That Adam should have understood it, as some of his degenerate sons have pretended to do, in a literal sense, is absolutely impossible. He knew well that it was the great God of heaven and earth who was speaking, and that such a Being was incapable of trifling with the wretchedness of his fallen creature. The sentence denounced upon himself and his wife was awful and severe. The woman was doomed to sorrow in conception; the man to sorrow and travel all the days of his life. The ground was cursed for his sake; and the end of the judgment was, "Dust thou art, and to dust thou shalt return." Had our first parents been thus left, they must have looked upon themselves as rejected by their Maker, delivered up to trouble and sorrow in the world, and as having no hope in any other. With such impressions on their minds they could have retained no sense of religion; for religion, when unaccompanied by hope, is a state of frenzy and distraction: yet it is certain that they could have no hope from any thing expressly recorded by Moses, except what they might draw from this sentence passed on their deceiver. Let us then endeavour to ascertain what consolation it could afford them.

At that awful juncture, they must have been sensible that their fall was the victory of the serpent, whom by experience they had found to be an enemy to God and to man. It could not therefore but be some comfort to them to hear this enemy first condemned, and to see that, however he had prevailed against them, he had gained no victory over their Maker. By his condemnation they were secured from thinking that there was any malignant being equal to the Creator in power and dominion; an opinion which, through the prevelancy of evil, gained ground in after times, and was destructive of all true religion. The belief of God's supreme dominion being thus preserved, it was still necessary to give them such hopes as might induce them to love as well as to fear him; and these they could not but conceive when they heard from the mouth of their Creator and Judge, that the serpent's victory was not complete even over themselves; that they and their posterity should be enabled to contest his empire; and that though they were to suffer much in the struggle, they should yet finally prevail, bruise the serpent's head, and deliver themselves from his power and dominion.

This prophecy therefore was to our first parents a light shining in a dark place. All that they could certainly conclude from it was, that their case was not desperate; that some remedy, some deliverance from the evil they were under, would in time appear; but *when* or *where*, or by *what means* they were to be delivered, they could not possibly understand, unless the matter was further revealed to them, as probably it was at the institution of sacrifice. (See SACRIFICE). Obscure, however, as this promise or prophecy was, it served after the fall as a foundation for religion, and trust and confidence towards God in hopes of deliverance in time from the evils of disobedience: and this appears to have been the sole purpose for which it was given, and not, as some well-meaning though weak advocates for Christianity have imagined, as a prediction pointing *directly* to the cross of Christ.

As this prophecy was the first, so is it the only considerable one in which we have any concern from the creation to the days of Noah. It was proportioned to the then wants and necessities of the world, and was the grand charter of God's mercy after the fall. Nature had

had no certain help for ſinners; her rights were loſt with her innocence. It was therefore neceſſary either to deſtroy the offenders, or to raiſe them to a capacity of ſalvation, by giving them ſuch hopes as might enable them to exerciſe a reaſonable religion. So far the light of this prophecy extended. By what *means* God intended to work their ſalvation, he did not expreſsly declare; and who has a right to complain that he did not, or to preſcribe to him rules in diſpenſing his mercy to the children of men?

11
he curſe
moved
m the
round.

Upon the hopes of mercy which this prophecy gives in very general terms, mankind reſted till the birth of Noah. At that period a new prophecy was delivered by Lamech, who foretels that his ſon ſhould comfort them concerning the work and toil of their hands, "becauſe of the *earth which the Lord had curſed.*" We are to remember that the curſe pronounced upon the earth was part of the ſentence paſſed upon our firſt parents; and when that part was remitted, if it ever was remitted, mankind would acquire new and more lively hopes that in God's good time they ſhould be freed from the whole. But it has been ſhown by biſhop Sherlock*, that this declaration of Lamech's was a prediction, that during the life of his ſon the curſe ſhould be taken off from the earth: and the ſame prelate has proved with great perſpicuity, and in the moſt ſatisfactory manner, that this happy revolution actually took place after the flood. The limits preſcribed to an article of this kind will not permit us even to abridge his arguments. We ſhall only obſerve, that the truth of his concluſion is manifeſt from the very words of ſcripture; for when God informs Noah of his deſign to deſtroy the world, he adds, "But with thee will I eſtabliſh my covenant:" and as ſoon as the deluge was over, he declared that he "would not again curſe the ground any more for man's ſake; but that while the earth ſhould remain, ſeed-time and harveſt, and cold and heat, and ſummer and winter, and day and night, ſhould not ceaſe." From this laſt declaration it is apparent that a curſe *had* been on the earth, and that ſeed-time and harveſt had often failed; that the curſe was now taken off; and that in conſequence of this covenant, as it is called, with Noah and his ſeed and with every living creature, mankind ſhould not henceforth be ſubjected to toil ſo ſevere and ſo generally fruitleſs.

*Uſe and
tent of
rophecy.*

12
future
ſe not
hen explicitly re-
ealed.

It may ſeem ſurpriſing perhaps to ſome, that after ſo great a revolution in the world as the deluge made, God ſhould ſay nothing to the remnant of mankind of the puniſhments and rewards of another life, but ſhould make a new covenant with them relating merely to fruitful ſeaſons and the bleſſings of the earth. But in the ſcriptures we ſee plainly a gradual working of providence towards the redemption of the world from the curſe of the fall; that the temporal bleſſings were firſt reſtored as an earneſt and pledge of better things to follow; and that the covenant given to Noah had, ſtrictly ſpeaking, nothing to do with the hopes of futurity, which were reſerved to be the matter of another covenant, in another age, and to be revealed by him, whoſe province it was to "bring life and immortality to light through the goſpel." But if Noah and his forefathers expected deliverance from the whole curſe of the fall, the actual deliverance from one part of it was a very good pledge of a further deliverance to be expected in time. Man himſelf was curſed as well as the ground; he was doomed to duſt: and fruitful ſeaſons are but a ſmall relief, compared to the greatneſs of his loſs. But when fruitful ſeaſons came, and one part of the curſe was evidently abated, it gave great aſſurance that the other ſhould not laſt for ever, but that by ſome means, ſtill unknown to them, they ſhould be freed from the whole, and finally bruiſe the ſerpent's head, who, at the deluge, had ſo ſeverely bruiſed man's heel.

Upon this aſſurance mankind reſted for ſome generations, and practiſed, as we have every reaſon to believe, a rational worſhip to the one God of the univerſe. At laſt, however, idolatry was by ſome means or other introduced (ſee POLYTHEISM), and ſpread ſo univerſally through the world, that true religion would in all probability have entirely failed, had not God viſibly interpoſed to preſerve ſuch a ſenſe of it as was neceſſary for the accompliſhment of his great deſign to reſtore mankind. This he did by calling Abraham from amidſt his idolatrous kindred, and renewing to him the word of prophecy: "Get thee out of thy country (ſaid he), and from thy kindred, and from thy father's houſe, unto a land that I will ſhew thee. And I will make of thee a great nation, and I will bleſs thee and make thy name great; and thou ſhalt be a bleſſing. And I will bleſs them that bleſs thee, and curſe him that curſeth thee; and in thee ſhall all the families of the earth be bleſſed." Theſe magnificent promiſes are ſeveral times repeated to the father of the faithful with additional circumſtances of great importance, ſuch as, "that he ſhould be multiplied exceedingly; that he ſhould be a father of many nations; that kings ſhould come out of him;" and above all, that God would eſtabliſh an *everlaſting covenant* with him and his ſeed, to give him and them all the land of Cannan for an *everlaſting poſſeſſion*, and to be *their God.*"

13
Promiſe to
Abraham,

Upon ſuch of theſe promiſes as relate to temporal bleſſings we need not dwell. They are much of the ſame nature with thoſe which had been given before to Lamech, Noah, Shem, and Japheth; and all the world knows how amply and literally they have been fulfilled. There was however ſo little probability in nature of their accompliſhment at the time when they were made, that we find the patriarch aſking "Whereby he ſhould *know* †, that he ſhould inherit ſuch an extent of country?" And as the promiſes that he ſhould inherit it were meant to be a foundation for religion and confidence in God, a miraculous ſign was given him that they came indeed from the ſpirit of truth. This removed from his mind every doubt, and made him give the fulleſt credit, not only to them, but alſo to that other promiſe, "that in his feed ſhould all the nations of the earth be bleſſed."

† Geneſis xv. 8. &c.

What diſtinct notion he had of this bleſſing, or in what manner he hoped it ſhould be effected, we cannot pretend to ſay. "But that he underſtood it to be a promiſe of reſtoring mankind, and delivering them from the remaining curſe of the fall, there can be no doubt. He knew that death had entered by ſin; he knew that God had promiſed victory and redemption to the ſeed of the woman. Upon the hopes of this reſtoration the religion of his anceſtors was founded; and when God, from whom this bleſſing on all men was expected, did expreſsly promiſe a bleſſing on all men, and in this promiſe founded his everlaſting covenant—what could Abraham elſe expect but the completion in his ſeed of that ancient promiſe and prophecy concerning the victory

to

to be obtained by the woman's ſeed? The curſe of the ground was expiated in the flood, and the earth reſtored with a bleſſing, which was the foundation of the temporal covenant with Noah; a large ſhare of which God expreſsly grants to Abraham and his poſterity particularly, together with a promiſe to bring, by their means, a new and further bleſſing upon the whole race of men. If we lay theſe things to heart, we cannot ſuppoſe that leſs could be expected from the new promiſe or prophecy given to Abraham than a deliverance from that part of the curſe ſtill remaining on men: *Duſt thou art and to duſt thou ſhalt return.* In virtue of this covenant Abraham and his poſterity had reaſon to expect that the time would come when man ſhould be called from his duſt again. For this expectation they had his aſſurance who gave the covenant, that he would be their God for ever. Well might our Saviour then tell the ſons of Abraham, that even Moſes at the buſh ſhowed the reſurrection of the dead, when he called the Lord the God of Abraham, and the God of Iſaac, and the God of Jacob *."

* Sherlock's *Uſe and Intent of Prophecy.*

14 To Iſaac and Jacob.

Theſe promiſes made to Abraham were renewed to Iſaac and Jacob; to the laſt of whom it was revealed, not only that all the nations of the earth ſhould be bleſſed in his ſeed, but that the bleſſing ſhould ſpring from his ſon Judah. It is, however, by no means evident that any one of thoſe patriarchs knew preciſely by what *means* (A) the curſe of the fall was to be entirely removed, and all men called from their duſt again. It was enough that they were convinced of the fact in general terms, ſince ſuch conviction was a ſufficient foundation of a rational religion; and the deſcendants of Abraham had no other foundation upon which to reſt their hopes, and pay a cheerful worſhip to the God of their fathers, till the giving of the law to Moſes.

15 The law of Moſes and the ſucceeding prophets

Then indeed they were incorporated into a ſociety with municipal laws of their own and placed under a theocratic government; the temporal promiſes made to their fathers were amply fulfilled; religion was maintained among them by rewards and puniſhments equally diſtributed in this world (ſee THEOLOGY): and a ſeries of prophets ſucceeding one another pointed out with greater and greater clearneſs, as the fulneſs of time approached, the perſon who was to redeem mankind from the power of death; by what means he was to work that great redemption, and at what preciſe period he was to make his appearance in the world. By theſe ſupernatural interpoſitions of divine providence, the principles of pure theiſm and the practice of true religion were preſerved among the children of Iſrael, when all other nations were ſunk in the groſſeſt idolatry, and wallowed in the moſt abominable vices; when the far-famed Egyptians, Greeks, and Romans, fell down with adoration to ſtocks and ſtones and the vileſt reptiles; and when they had no well grounded hope of another life, and were in fact without God in the world.

16 Were intended to keep alive a ſenſe of religion

From this ſhort deduction, we think ourſelves intitled to conclude, that the *primary* uſe and intent of prophecy, under the various diſpenſations of the Old Teſtament, was not, as is too often ſuppoſed, to eſtabliſh the divine miſſion of Jeſus Chriſt, but to keep alive in the minds of thoſe to whom it was given, a ſenſe of religion, and a hope of future deliverance from the curſe of the fall. It was, in the expreſſive language of St Peter, "a light that ſhone in a dark place, unto which men did well to take heed until the day dawned and the day-ſtar aroſe in their hearts." But though this was certainly the original intent of prophecy (for Chriſt, had he never been foretold, would have proved himſelf to be the Son of God with power by his aſtoniſhing miracles, and his reſurrection from the dead), yet it cannot be denied, that a long ſeries of prophecies, given in different and far diſtant ages, and having all their completion in the life, death, and reſurrection, of Jeſus, concur very forcibly with the evidence of miracles to prove that he was the ſeed of the woman ordained to bruiſe the head of the ſerpent, and reſtore man to his forfeited inheritance. To the Jews the force of this evidence muſt have been equal, if not ſuperior, to that of miracles themſelves; and therefore we find the Apoſtles and firſt preachers of the goſpel, in their addreſſes to them conſtantly appealing to the law and the prophets, whilſt they urged upon the Gentiles the evidence of miracles.

17 The prophecies conſidered in connection

In order to form a right judgment of the argument for the truth of Chriſtianity drawn from the ſure word of prophecy, we muſt not conſider the prophecies given in the Old Teſtament as ſo many *predictions* only independent of each other; for if we do, we ſhall totally loſe ſight of the purpoſe for which they were originally given, and ſhall never be able to ſatiſfy ourſelves when confronted by the objections of unbelievers. It is eaſy for men of leiſure and tolerable parts to find difficulties in particular predictions, and in the application of them made by writers, who lived many hundred years ago, and who had many ancient books and records of the Jewiſh church, from which they drew many paſſages, and perhaps ſome prophecies; which books and records we have not to enable us to underſtand, and to juſtify their applications. But it is not ſo eaſy a matter to ſhow, or to perſuade the world to believe, that a chain of prophecies reaching through ſeveral thouſand years, delivered at different times, yet manifeſtly ſubſervient to one and the ſame adminiſtration of providence from beginning to end, is the effect of art and contrivance and religious fraud. In examining the ſeveral prophecies

8

(A) This they certainly could not know from the promiſes expreſſed in the very general terms in which they are recorded in the book of Geneſis. It is, however, not improbable that thoſe promiſes, as they immediately received them, were conceived in terms more preciſe and particular; and, at all events, Dr Warburton has proved to the full conviction of every man who is not a determined unbeliever, that Abraham was commanded to ſacrifice his ſon Iſaac, not only as a trial of his obedience, but alſo that God might give him what he earneſtly deſired, a ſcenical repreſentation of the means by which mankind were to be redeemed from death. The learned writer thinks, and his reaſoning compels us to think with him, that to this tranſaction our Saviour alludes when he ſays, "Your father Abraham rejoiced to ſee my *day*, and he ſaw it and was glad."

cies recorded in the Old Teftament, we are not to fuppofe that each of them *exprefsly* pointed out and *clearly* characterized Jefus Chrift. Had they done fo, inftead of being a fupport to religion in general, the purpofe for which they were originally intended, they would have had a very different effect, by making thofe to whom they were given repine at being placed under difpenfations fo very inferior to that of the gofpel. We are therefore to inquire only whether all the notices, which, in general and often metaphorical terms, God gave to the fathers of his intended falvation, are perfectly anfwered by the coming of Chrift; and we fhall find that nothing has been promifed with refpect to that fubject which has not been performed in the ampleft manner. If we examine the prophecies in this manner, we fhall find that there is not one of them, which the Apoftles have applied to the Meffiah, that is not applicable in a rational and important fenfe to fomething in the birth, life, preaching, death, refurrection, and afcenfion of Jefus of Nazareth; that as applied to him they are all confiftent with each other; and that though fome few of them may be applied without abfurdity to perfons and events under the Jewifh difpenfation, Chrift is the only perfon that ever exifted in whom they all meet as in a centre. In the limits prefcribed us, it is impoffible that we fhould enter upon a particular proof of this pofition. It has been proved by numberlefs writers, and, with refpect to the moft important prophecies, by none with greater fuccefs than bifhop Sherlock in his *Ufe and Intent of Prophecy in the feveral ages of the world;* a work which we recommend to our readers as one of the moft valuable on the fubject in our own or any other language.

8 ...tion the ...rity ...phe-

But admitting that it would have been improper, for the reafons already hinted at, to have given a clear and precife defcription of Chrift, and the Chriftian difpenfation, to men who were ordained to live under difpenfations lefs perfect, how, it may be afked, comes it to pafs that many of the prophecies applied by the writers of the gofpel to our Saviour and his actions are ftill dark and obfcure, and fo far from belonging evidently to him and to him only, that it requires much learning and fagacity to fhow even now the connection between fome prophecies and the events?

9 ...ered.

In anfwer to thefe queftions, the learned prelate juft referred to obferves, "That the obfcurity of prophecy does not arife from hence, that it is a relation or defcription of fomething *future;* for it is as eafy to fpeak of things future plainly, and intelligibly, as it is of things paft or prefent. It is not, therefore, of the nature of prophecy to be obfcure; for it may eafily be made, when he who gives it thinks fit, as plain as hiftory. On the other fide, a figurative and dark defcription of a future event will be figurative and dark ftill when the event happens; and confequently will have all the obfcurity of a figurative and dark defcription as well after as before the event. The prophet Ifaiah defcribes the peace of Chrift's kingdom in the following manner: 'The wolf fhall dwell with the lamb, and the leopard fhall lie down with the kid, and the calf and the young lion, and the fatling, together, and a little child fhall lead them.' Nobody, fome modern Jews excepted, ever underftood this literally; nor can it now be *literally* applied to the ftate of the gofpel. It was and is capable of different interpretations: it may mean temporal peace, or that internal and fpiritual peace—that tranquillity of mind, which fets a man at peace with God, himfelf, and the world. But whatever the true meaning is, this prophecy does no more obtrude one determinate fenfe upon the mind fince the coming of Chrift than it did before. But then we fay, the ftate of the gofpel was very properly prefigured in this defcription, and is as properly prefigured in a hundred more of the like kind; and fince they all agree in a fair application to the ftate of the gofpel, we ftrongly conclude, that this ftate was the thing foretold under fuch expreffions. So that the argument from prophecy for the truth of Chriftianity does not reft on this, that the event has neceffarily limited and afcertained the particular fenfe and meaning of every prophecy; but in this, that every prophecy has in a proper fenfe been completed by the coming of Chrift. It is abfurd, therefore, to expect clear and evident conviction from every fingle prophecy applied to Chrift; the evidence muft arife from a view and comparifon of all together." It is doubtlefs a great miftake to fuppofe that prophecy was intended folely or chiefly for their fakes in whofe time the events predicted are to happen. What great occafion is there to lay in fo long beforehand the evidence of prophecy to convince men of things that are to happen in their own times; the truth of which they may, if they pleafe, learn from their own fenfes? Yet fome people are apt to talk as if they thought the truth of the events predicted depended very much on the evidence of prophecy: they fpeak, for inftance, as if they imagined the certainty and reality of our Saviour's refurrection were much concerned in the clearnefs of the prophecies relating to that great and wonderful event, and feem to think that they are confuting the truth of his refurrection when they are pointing out the abfurdity of the prophecies relating to it. But can any thing be more abfurd? For what ground or pretence is there to inquire whether the prophecies foretelling that the Meffiah fhould die and rife again do truly belong to Chrift, unlefs we are firft fatisfied that Chrift died and rofe again?

The part which unbelievers ought to take in this queftion, if they would make any ufe of prophecy, fhould be, to fhow from the prophets that Chrift was neceffarily to rife from the dead; and then to prove that in fact Jefus never did rife. Here would be a plain confequence. But if they like not this method, they ought to let the prophecies alone; for if Chrift did not rife, there is no harm done though the prophets have not foretold it. And if they allow the refurrection of Chrift, what do they gain by difcrediting the prophets? The event will be what it is, let the prophecies be what they will.

Thefe confiderations fhow how far the gofpel is *neceffarily* concerned in prophetical evidence, and how clear the prophecies fhould be. Chrift claims to be the perfon foretold in the law and the prophets; and as truth muft ever be confiftent with itfelf, this claim muft be true as well as all others. This is the part then to be tried on the evidence of prophecy: Is Chrift that perfon defcribed and foretold under the Old Teftament or not? Whether all the prophecies relating to him be plain or not plain, it matters little; the fingle queftion is, Are there enough plain to fhow us that Chrift is the perfon foretold under the Old Teftament? If there be, we

Prophecy we are at an end of our inquiry, and want no farther help from prophecy; especially since we have seen the day dawn and enjoyed the marvellous light of the gospel of God.

20 Objections from the clearness of some prophecies,

But so unreasonable are unbelievers, that whilst some of them object to the obscurity of the prophecies, others have rejected them altogether on account of their clearness, pretending that they are histories and not predictions. The prophecies against which this objection has been chiefly urged are those of Daniel, which were first called in question by the famous Porphyry. He affirmed that they were not composed by Daniel, whose name they bear, but by some author who lived in Judea about the time of Antiochus Epiphanes; because all to that time contained true history, but that all the facts beyond that were manifestly false.

21 Answered,

This method of opposing the prophecies, as a father of the church rightly observes, is the strongest testimony of their truth: for they are so exactly fulfilled, that to infidels the prophet seemed not to have foretold things future, but to have related things past. To an infidel of this age, if he has the same ability and knowledge of history that Porphyry had, all the subsequent prophecies of Daniel, except those which are still fulfilling, would appear to be history and not prophecy: for it entirely overthrows the notion of their being written in the days of *Antiochus Epiphanes*, or of the *Maccabees*, and establishes the credit of Daniel as a prophet beyond contradiction, that there are several of those prophecies which have been fulfilled since that period as well as before; nay, that there are prophecies of Daniel which are fulfilling at this very time in the world.

22 From what has happened since the objection was first started

Our limits will not permit us to enter into the objections which have been made to this prophet by the author of *The Literal Scheme of Prophecy considered*; nor is there occasion that we should enter into them. They have been all examined and completely answered by Bishop Chandler in his *Vindication of his Defence of Christianity*, by Mr Samuel Chandler in his *Vindication of the Antiquity and Authority of Daniel's Prophecies*, and by Bishop Newton in his excellent *Dissertations on the Prophecies*. To these authors we refer the reader; and shall conclude the present article with a view of some prophecies given in very remote ages, which are in this age receiving their accomplishment.

23 And from facts of the present age.

Of these the first is that of Noah concerning the servitude of the posterity of Canaan. In the greater part of original manuscripts, and in our version of the holy scriptures, this prophecy is thus expressed: "Cursed be Canaan; a servant of servants shall he be unto his brethren:" but in the Arabic version, and in some copies of the Septuagint, it is, "Cursed be *Ham* the father of Canaan; a servant of servants shall he be to his brethren." Whether the curse was really pronounced upon Ham, which we think most probable, or only upon his son Canaan, we shall find the prediction remarkably fulfilled, not barely ages after the book of Genesis was very generally known, but also at this very day. It is needless to inform any man who has but looked into the Old Testament, that when the ancient patriarchs pronounced either a curse or a blessing upon any of their sons, they meant to declare the future fortunes, not of that son individually, but of his descendants as a tribe or a nation. Let us keep this in mind, and proceed to compare with Noah's prophecy *first* the fortunes of the descendants of Canaan, the fourth son of Ham, and then the fortunes of the posterity of Ham by his other sons.

With the fate of the Canaanites every reader is acquainted. They were conquered by Joshua several centuries after the delivery of this prophecy; and such of them as were not exterminated were by him and Solomon reduced to a state of the lowest servitude to the Israelites, the posterity of Shem the brother of Ham. The Greeks and Romans, too, who were the descendants of Japheth, not only subdued Syria and Palestine, but also pursued and conquered such of the Canaanites as were anywhere remaining, as for instance the Tyrians and Carthaginians, of whom the former were ruined by Alexander and the Grecians, and the latter by Scipio and the Romans. Nor did the effects of the curse stop there. The miserable remainder of that devoted people have been ever since slaves to a foreign yoke; first to the Saracens who are descended from Shem, and afterwards to the Turks who are descended from Japheth; and under the Turkish dominion they groan at this day.

If we take the prophecy as it stands in the Arabic version, its accomplishment is still more remarkable. The whole continent of Africa was peopled principally by the posterity of Ham. And for how many ages have the better parts of that country lain under the dominion first of the Romans, then of the Saracens, and now of the Turks? In what wickedness, ignorance, barbarity, slavery, and misery, live most of its inhabitants? and of the poor negroes how many thousands are every year sold and bought like beasts in the market, and conveyed from one quarter of the world to do the work of beasts in another; to the full accomplishment indeed of the prophecy, but to the lasting disgrace of those who are from the love of gain the instruments of fulfilling it. Nothing can be more complete than the execution of the sentence as well upon Ham as upon Canaan; and the hardiest infidel will not dare to say that it was pronounced after the event.

The next prophecy which we shall notice is that of Abraham concerning the multitude of his descendants; which every one knows is still fulfilled in the Jews even in their dispersed state, and therefore cannot have been given after the event of which it speaks.

Of the same kind are the several prophecies concerning Ishmael; of which some have been fulfilled, and others are at present fulfilling in the most astonishing manner. Of this son of Abraham it was foretold, that "he should be a wild man; that his hand should be against every man, and every man's hand against him; that he should dwell in the presence of all his brethren; that he should be multiplied exceedingly, beget twelve princes, and become a great nation." The sacred historian who records these prophecies adds, that "God was with the lad, and he grew, and dwelt in the wilderness, and became an archer."

To show how fully and literally all these prophecies have been accomplished, would require more room than we have to bestow; and to the reader of history the labour would be superfluous. We shall therefore only request the unbeliever to attend to the history of the Arabs, the undoubted descendants of Ishmael; and to say how it comes to pass, that though they have been robbers by land and pirates by sea for time immemo-

rial, though their hands have been againſt every man, and every man's hand againſt them, they always have dwelt, and at this day dwell, in the preſence of their brethren, a free and independent people. It cannot be pretended that no attempt has ever been made to conquer them; for the greateſt conquerors in the world have all in their turns attempted it: but though ſome of them made great progreſs, not one was ever crowned with ſucceſs. It cannot be pretended that the inacceſſibleneſs of their country has been their protection; for their country has been often penetrated, though it never was entirely ſubdued. When in all human probability they have been on the brink of ruin, they were ſignally and providentially delivered. Alexander was preparing an expedition againſt them, when he was cut off in the flower of his age. Pompey was in the career of his conqueſts, when urgent affairs called him elſewhere. Ælius Gallius had penetrated far into their country, when a fatal diſeaſe deſtroyed great numbers of his men, and obliged him to return. Trajan beſieged their capital city, but was defeated by thunder and lightning and whirlwinds. Severus beſieged the ſame city twice, and was twice repelled from before it. The Turks, though they were able to wreſt from them their foreign conqueſts, have been ſo little able to ſubdue the Arabs themſelves, or even to reſtrain their depredations, that they are obliged to pay them a ſort of annual tribute for the ſafe paſſage of the pilgrims who go to Mecca to pay their devotions. On theſe facts we ſhall not exclaim. He who is not ſtruck upon comparing the ſimple hiſtory of this ſingular people with the prophecies ſo long ago delivered of them and their great anceſtor, whoſe love of liberty is compared to that of the wild aſs, would riſe wholly unmoved from our exclamations.

24 The diſperſion of the Jews plainly foretold,

A fourth prophecy of this kind, which cannot be alleged to have been uttered after the event, is the denunciation of Moſes againſt the children of Iſrael in caſe of their diſobedience; which is ſo literally fulfilled, that even at this moment it appears rather a hiſtory of the preſent ſtate of the Jews, than a remote prediction of their apoſtacy and puniſhment. "And the Lord ſhall ſcatter thee among all people from the one end of the earth even unto the other. And among theſe nations ſhalt thou find no eaſe, neither ſhall the ſole of thy foot have reſt; but the Lord ſhall give thee there a trembling heart, and failing of eyes, and ſorrow of mind. And thy life ſhall hang in doubt before thee; and thou ſhalt fear day and night, and ſhalt have none aſſurance of thy life." (Deut. xxviii. 64, 65, 66.) "And thou ſhalt become an aſtoniſhment, a proverb, and a bye-word, among all nations, whither the Lord ſhall lead you." (Deut. xxviii. 37.)

Similar to this denunciation, but attended with ſome circumſtances ſtill more wonderful, is the following prediction of the prophet Hoſea: "The children of Iſrael ſhall abide many days without a king, and without a prince, and without a ſacrifice, and without an image, and without an ephod, and without teraphim. Afterwards ſhall the children of Iſrael return, and ſeek the Lord their God, and David their king; and ſhall fear the Lord and his goodneſs in the latter days (B)." In this paſſage we find the ſtate of the Jews for the laſt 1700 years clearly and diſtinctly deſcribed with all its circumſtances. From the time that they rejected their Meſſiah all things began to work towards the deſtruction of their polities both civil and religious; and within a few years from his death, their city, temple, and government, were utterly ruined; and they themſelves, not carried into a gentle captivity, to enjoy their laws, and live under governors of their own as they did in Babylon, but they were ſold like beaſts in a market, and became ſlaves in the ſtricteſt ſenſe; and from that day to this have had neither prince nor chief among them. Nor will any one of them ever be able, after all their pretences, to prove his deſcent from Aaron, or to ſay with certainty whether he is of the tribe of Judah or of the tribe of Levi, till he ſhall diſcover that unknown country where never mankind dwelt, and where the apocryphal Eſdras has placed their brethren of the ten tribes. This being the caſe, it is impoſſible they can have either an altar, or a ſacrifice, or a prieſthood, according to the inſtitution of Moſes, but are evidently an outcaſt people living under laws which cannot be fulfilled.

The cauſe of this deplorable condition is likewiſe aſſigned with the ſame perſpicuity: They are ſcattered over the face of the earth, becauſe they do not acknowledge Chriſt for the Meſſiah; becauſe they do not ſubmit to their own king, the true David. In the prophetic writings the name of David is frequently given to the Meſſiah, who was to deſcend from that prince. Thus Ezekiel, ſpeaking of the kingdom of Chriſt, ſays, "I will ſet up one Shepherd over them, and he ſhall feed them, even my ſervant David; he ſhall feed them, and he ſhall be their ſhepherd." And Jeremiah ſays, "They ſhall ſerve the Lord their God, and David their king, whom I will raiſe up unto them." 25 And the cauſe of it.

That in theſe places, as well as in the paſſage under conſideration, the Meſſiah is meant, is undeniable; for David the ſon of Jeſſe was dead long before any of the three prophets was born; and by none of them it is ſaid, "afterwards David their king ſhall come again;" but "afterwards the children of Iſrael ſhall *return* to David their king," they ſhall recover from their blind infatuation, and ſeek him whom they have not yet known. By their not receiving Jeſus for the Chriſt, they have forfeited all claim to the divine favour, and are, of conſequence, "without a king, and without a chief, and without a ſacrifice, and without an altar, and without a prieſthood."

The time, however, will come, when they ſhall return and ſeek "the Lord their God and David their king;" when they ſhall tremble before him whom their fathers crucified, and honour the ſon even as they honour the father. That this part of the prophecy will in time be as completely fulfilled as the other has been, may be confidently expected from the wonderful preſervation of the Jews for ſo many ages. Scattered as they 26 Their return alſo foretold.

(B) Such is our tranſlation of this remarkable prophecy; but the Greek verſion of the Seventy has it, perhaps more properly, thus: "The children of Iſrael ſhall abide many days without a king, and without a chief, and without ſacrifice, and without an altar, and without a prieſthood, and without prophecies. Afterwards," &c.

they are over the whole earth, and hated as they are by all nations, it might naturally be thought, that in procefs of time they would have coalefced with their conquerors, and have been ultimately abforbed and annihilated by the union, fo that not a trace of them fhould now have remained; yet the fact is, that, difperfed as they have ever fince been over the whole face of the globe, they have never, in a fingle inftance in any country, loft their religious or national diftinctions; and they are now generally fuppofed to be as numerous as they were under the reigns of David and Solomon. This is contrary to all hiftory, and all experience of the courfe of human affairs in fimilar cafes; it has been boldly and juftly ftyled a ftanding miracle. Within 1000 or 1200 years back, a great variety of extraordinary and important revolutions have taken place among the nations of Europe. In the fouthern part of this ifland the Britons were conquered by the Saxons, the Saxons by the Danes, and the Danes and Saxons by the Normans; but in a few centuries thefe oppofite and hoftile nations were confolidated into one indiftinguifhable mafs. Italy, about the fame time that Britain was fubdued by the Saxons, was conquered by the Goths and Vandals: and it is not eafy to conceive a more ftriking contraft than that which fubfifted between the polifhed inhabitants of that delightful country and their favage invaders; and yet how foon did all diftinction ceafe between them! In France, the Roman colonies gradually affimilated with the ancient Gauls; and in Spain, though the Moors continued for feveral ages, and till their final expulfion, a diftinct people, yet after they were once reduced to a ftate of fubjection, their numbers very fenfibly diminifhed; and fuch of them as were fuffered to remain after their laft overthrow have been long fince fo blended with the Spaniards that they cannot now be diftinguifhed. But with regard to the Jews, the wonder is, that though they do not in any country where they are fettled bear any proportion to the natural inhabitants, though they are univerfally reduced to a ftate of the loweft fubjection, and even expofed to hatred, contempt, and perfecution; yet in no inftance does there feem to be the leaft appearance or probability of their numbers being diminifhed, in no inftance do they difcover any decay of attachment to their religious principles. Whence then comes it that this people alone, who, having no form of government or a republic anywhere fubfifting, are without the means by which other people are kept united and diftinct, fhould ftill be preferved amongft fo many different nations? How comes it, when they have been thus fcattered into fo many diftant corners, like duft which cannot be perceived, that they fhould ftill fo long furvive the diffolution of their own ftate, as well as that of fo many others? To thefe queftions the anfwer is obvious: They are preferved, that, as a nation, "they may return and feek the Lord their God and David their king, and fear the Lord and his goodnefs in the latter days."

27
Of prophecies refpecting the Chriftian church.

We might here fubjoin many prophecies both from the Old and the New Teftament, and efpecially from the writings of St Paul and St John, which fo clearly defcribe the various fortunes of the Chriftian church, her progrefs to that ftate of general corruption under which fhe was funk three centuries ago, and her gradual reftoration to her primitive purity, that they cannot be fuppofed to proceed from the cunning craftinefs of men, or to have been written after the events of which they fpeak. To do juftice to thefe, however, would require a volume, and many excellent volumes have been written upon them. The reader who wifhes for fatisfaction on fo interefting a fubject will do well to confult the writings of Mr Mede and Sir Ifaac Newton, together with Bifhop Newton's Differtations, and the Sermons of Hurd, Halifax, and Bagot, preached at Warburton's lecture. We fhall only obferve, that one of the ableft reafoners that Great Britain ever produced, after having paid the clofeft attention to the predictions of the New Teftament, hath been bold enough to put the truth of revealed religion itfelf upon the reality of that prophetic fpirit which foretold the defolation of Chrift's church and kingdom by antichrift. "If (fays he), IN THE DAYS OF ST PAUL AND ST JOHN, there was any footftep of fuch a fort of power as this in the world; or if there HAD BEEN any fuch power in the world; or if there WAS THEN any appearance or probability that could make it enter into the heart of man to imagine that there EVER COULD BE any fuch kind of power in the world, much lefs in the *temple* or *church of God;* and if there be not NOW fuch a power actually and confpicuoufly exercifed in the world; and if any picture of this power, DRAWN AFTER THE EVENT, can now defcribe it more plainly and exactly than it was originally defcribed in the words of the prophecy—then may it, with fome degree of plaufibility, be fuggefted, that the prophecies are nothing more than enthufiaftic imaginations."

Upon the whole, we conclude with Bifhop Sherlock, that the various prophecies recorded in the Holy Scriptures were given, not to enable man to forefee with clearnefs future events, but to fupport the feveral difpenfations of religion under which they were refpectively promulgated. The principal prophecies recorded in the Old Teftament led mankind to hope for a complete deliverance from the curfe of the fall; and therefore tended to fill their minds with gratitude, and to enforce a cheerful obedience to that God who in the midft of judgment remembereth mercy. The prophecies, whether in the Old or New Teftament, that pourtray the prefent ftate of the Jews, and the various fortunes of the Chriftian church, as they are daily fulfilling in the prefence of all men, are the ftrongeft poffible proof of the divinity of our holy religion, and fupply to us in the latter days the place of miracles, by which it was at firft eftablifhed.

PROPHET, in general, a perfon who foretels future events; but is particularly applied to fuch infpired perfons among the Jews as were commiffioned by God to declare his will and purpofes to that people. Among the canonical books of the Old Teftament we have the writings of 16 prophets, four of whom are denominated the *greater prophets*, viz. Ifaiah, Jeremiah, Ezekiel, and Daniel; fo called from the length or extent of their writings, which exceed thofe of the others, viz. Hofea, Joel, Amos, Obadiah, Jonah, Micah, Nahum, Habakkuk, Haggai, Zechariah, and Malachi, who are called the *leffer prophets*, from the fhortnefs of their writings. The Jews do not place Daniel among the prophets, becaufe, they fay, he lived the life of a courtier rather than that of a prophet. An account of the feveral writings of the prophets may be feen each under its particular head. See the article ISAIAH, &c.

Sons of the Prophets, in scripture history, an appellation given to young men who were educated in the schools or colleges under a proper master, who was commonly, if not always, an inspired prophet, in the knowledge of religion and in sacred music, and thus were qualified to be public preachers; which seems to have been part of the business of the prophets on the Sabbath-days and festivals. It is probable that God generally chose the prophets, whom he inspired, out of these schools. See Prophecy.

PROPITIATION, in theology, a sacrifice offered to God to assuage his wrath and render him propitious. Among the Jews there were both ordinary and public sacrifices, as holocausts, &c. offered by way of thanksgiving; and extraordinary ones, offered by particular persons guilty of any crime, by way of propitiation. The Romish church believe the mass to be a sacrifice of propitiation for the living and the dead. The reformed churches allow of no propitiation but that one offered by Jesus Christ on the cross. See Sacrifice.

PROPITIATORY, any thing rendering God propitious; as we say *propitiatory* sacrifices, in contradistinction to sacrifices which were *eucharistical*. Among the Jews the propitiatory was the cover or lid of the ark of the covenant; which was lined both within and withoutside with plates of gold, insomuch that there was no wood to be seen. This propitiatory was a type or figure of Christ, whom St Paul calls the propitiatory ordained from all ages. See *Ark of the Covenant*.

PROPOLIS, the name of a certain substance more tenacious than wax, with which the bees stop up all the holes or cracks in the sides of their hives. See Bee, n° 13.

PROPONTIS, or Sea of Marmora, a part of the Mediterranean, dividing Europe from Asia; it has the Hellespont or canal of the Dardanelles to the southwest, whereby it communicates with the Archipelago, and the ancient Bosphorus of Thrace, or Strait of Constantinople, to the north-east, communicating with the Black or Euxine Sea. It has two castles: that on the Asia side is on a cape, where formerly stood a temple of Jupiter. The castle of Europe is on an opposite cape, and had anciently a temple of Serapis. It is 120 miles long, and in some places upwards of 40 miles broad.

PROPORTION, the identity or similitude of two ratios. Hence quantities that have the same ratio between them are said to be proportional; *e. gr.* if A be to B as C to D, or 8 be to 4 as 30 to 15; A, B, C, D, and 8, 4, 30, and 15, are said to be in proportion, or are simply called proportionals. Proportion is frequently confounded with ratio; yet have the two in reality very different ideas, which ought by all means to be distinguished. Ratio is properly that relation or habitude of two things, which determines the quantity of one from the quantity of another, without the intervention of any third: thus we say the ratio of 5 and 10 is 2, the ratio of 12 and 24 is 2. Proportion is the sameness or likeness of two such relations: thus the relations between 5 and 10 and 12 and 24 being the same, or equal, the four terms are said to be in proportion. Hence ratio exists between two numbers, but proportion requires at least three. Proportion, in fine, is the habitude or relation of two ratios when compared together; as ratio is of two quantities. See Algebra, Arithmetic, and Geometry.

Arithmetical and Geometrical Proportion. See Progression.

Harmonical or Musical Proportion, is a kind of numeral proportion formed thus: of three numbers, if the first be to the third as the difference of the first and second to the difference of the second and third; the three numbers are in harmonical proportion.

Thus 2, 3, 6, are harmonical, because 2 : 6 : : 1 : 3. So also four numbers are harmonical, when the first is to the fourth as the difference of the first and second to the difference of the third and fourth.

Thus 24, 16, 12, 9, are harmonical, because 24 : 9 : : 8 : 3. By continuing the proportional terms in the first case, there arises an harmonical progression or series.

1. If three or four numbers in harmonical proportion be multiplied or divided by the same number; the products or quotients will also be in harmonical proportion: thus, if 6, 8, 12, which are harmonical, be divided by 2, the quotients 3, 4, 6, are also harmonical; and reciprocally their products by 2, viz. 6, 8, 12.

2. To find an harmonical mean between two numbers given; divide double the product of the two numbers by their sum, the quotient is the mean required; thus suppose 3 and 6 the extremes, the product of these is 18, which doubled gives 36; this divided by 9 (the sum of 3 and 6) gives the quotient 4. Whence 3, 4, 6, are harmonical.

3. To find a third harmonical proportional to two numbers given.

Call one of them the first term, and the other the second: multiply them together, and divide the product by the number remaining after the second is subtracted from double the first; the quotient is a third harmonical proportional: thus, suppose the given terms 3, 4, their product 12 divided by 2 (the remainder after 4 is taken from 6, the double of the first), the quotient is 6, the harmonical third sought.

4. To find a fourth harmonical proportion to three terms given: multiply the first into the third, and divide the product by the number remaining after the middle or second is subtracted from double the first; the quotient is a third harmonical proportion; thus supposing the numbers 9, 12, 16, a fourth will be found by the rule to be 24.

5. If there be four numbers disposed in order, whereof one extreme and the two middle terms are in arithmetical proportion; and the same middle terms with the other extreme are in harmonical proportion, the four are in geometrical proportion; as here 2 : 3 : : 4 : 6, which are geometrical; whereof 2, 3, 4, are arithmetical, and 3, 4, 6, harmonical.

6. If betwixt any two numbers you put an arithmetical mean, and also an harmonical one, the four will be in geometrical proportion: thus betwixt 2 and 6 an arithmetical mean is 4, and an harmonical one 3; and the four 2 : 3 : : 4 : 6, are geometrical.

We have this notable difference between the three kinds of proportion, arithmetical, harmonical, and geometrical; that from any given number we can raise a continued arithmetical series increasing *in infinitum*, but not

not decreasing: the harmonical is decreasable *in infinitum*, but not increasable; the geometrical is both.

PROPORTION, or *Rule of Three.* See ARITHMETIC, nº 13, 14, 15.

Reciprocal PROPORTION. See RECIPROCAL.

PROPORTION is also used for the relation between unequal things of the same kind, whereby their several parts correspond to each other with an equal augmentation or diminution.

Thus, in reducing a figure into little, or in enlarging it, care is taken to observe an equal diminution or enlargement, through all its parts; so that if one line, *e. gr.* be contracted by one-third of its length, all the rest shall be contracted in the same proportion.

PROPORTION, in architecture, denotes the just magnitude of the members of each part of a building, and the relation of the several parts to the whole; *e. gr.* of the dimensions of a column, &c. with regard to the ordonnance of a whole building.

One of the greatest differences among architects, M. Perrault observes, is in the proportions of the heights of entablatures with respect to the thickness of the columns, to which they are always to be accommodated.

In effect, there is scarce any work, either of the ancients or moderns, wherein this proportion is not different; some entablatures are even near twice as high as others:—yet it is certain this proportion ought of all others to be most regulated; none being of greater importance, as there is none wherein a defect is sooner spied, nor any wherein it is more shocking.

Compass of PROPORTION, a name by which the French, and after them some English, authors call the SECTOR.

PROPORTIONAL, relating to proportion. Thus we say, proportional compasses, parts, scales, spirals, &c.

PROPORTIONALS, in geometry, are quantities, either linear or numeral, which bear the same ratio or relation to each other.

PROPOSITION, in logic, part of an argument wherein some quality, either negative or positive, is attributed to a subject.

PROPOSITION, in mathematics, is either some truth advanced and shown to be such by demonstration, or some operation proposed and its solution shown. If the proposition be deduced from several theoretical definitions compared together, it is called a *theorem*; if from a praxis, or series of operations, it is called a *problem*. See the articles THEOREM and PROBLEM.

PROPOSITION, in oratory. See ORATORY, nº 28. 124.

PROPOSITION, in poetry, the first part of a poem, wherein the author proposes briefly, and in general, what he is to say in the body of his work. It should comprehend only the matter of the poem, that is, the action and persons that act. Horace prescribes modesty and simplicity in the proposition, and would not have the poet promise too much, nor raise in the reader too great ideas of what he is going to relate.

PROPREFECT, among the Romans, the prefect's lieutenant, or an officer whom the prefect of the pretorium commissioned to do part of his duty in his place.

PROPRETOR, a Roman magistrate, who, having discharged the office of pretor at home, was sent into a province to command there with his former pretorial authority. It was also an appellation given to those who, without having been pretors at Rome, were sent extraordinarily into the provinces to administer justice with the authority of pretors.

PROPRIETOR, or PROPRIETARY, is he who possesses any thing as his own in the utmost degree. Such monks were called *proprietary* as had reserved goods and effects to themselves, notwithstanding their formal renunciation of all at the time of their profession. They are frequently mentioned in the *Monast. Anglic.* &c. and were to be very severely dealt with; to be excommunicated, deprived of burial. &c. *Monachi proprietarii excommunicentur ab abbatibus: et, si in morte proprietarius inventus fuerit, ecclesiastica careat sepultura*, &c. Addit. ad Matt. Par.

PRO RATA, in commerce, a term sometimes used by merchants for *in proportion;* as each person must reap the profit or sustain the loss, *pro rata* to his interest, that is, in proportion to his stock.

PROROGATION, the act of prolonging, adjourning, or putting off, to another time. The difference between a prorogation and an adjournment of parliament is, that by prorogation the session is ended, and such bills as passed in either house, or both houses, and had not the royal assent, must at the next assembly begin again.

PROSCRIPTION, a publication made in the name of the chief or leader of a party, whereby he promises a reward to any one who shall bring him the head of one of his enemies.

Sylla and Marius by turns proscribed each other's adherents.—Under the triumvirate a great part of the best and bravest of the Romans fell by proscription.

The term took its rise from the practice of writing down a list of the persons names, and posting it in public; from *pro* and *scribo* "I write."

PROSE, the natural language of mankind, loose and unconfined by poetical measures, rhymes, &c. In which sense it stands opposed to verse.

There is, however, a species of prose which is measured, such as that in which epitaphs and other inscriptions are generally written; and indeed every man who has formed for himself a style writes in uniform periods regularly recurring. It has been much disputed whether a poem can be written in prose. We enter not into that dispute, as we have said enough on the subject elsewhere. See NOVEL.

The word *prose* comes from the Latin *prosa*, which some will have derived from the Hebrew *poras*, which signifies *expendit:* others deduce it from the Latin *prorsa*, of *prorsus*, "going forwards;" by way of opposition to *versa*, or "turning backwards," as is necessary in writing.

PROSECUTION, in the criminal law. The next step towards the punishment of offenders after COMMITMENT, is their prosecution, or the manner of their formal accusation. And this, in the English law, is either upon a previous finding of the fact by an inquest or grand jury; or without such previous finding.

The former way is either by PRESENTMENT or INDICTMENT. See these articles.

The

The remaining methods of proſecution are without any previous finding by a jury, to fix the authoritative ſtamp of veriſimilitude upon the accuſation. One of theſe, by the common law, was when a thief was taken *with the mainour*, that is, with the thing ſtolen upon him, *in manu*. For he might, when ſo detected, *flagrante delicto*, be brought into court, arraigned, and tried, without indictment: as by the Daniſh law he might be taken and hanged upon the ſpot without accuſation or trial. But this proceeding was taken away by ſeveral ſtatutes in the reign of Edward III. though in Scotland a ſimilar proceſs remains to this day. So that the only ſpecies of proceeding at the ſuit of the king, without a previous indictment or preſentment by a grand jury, now ſeems to be that of Information; which ſee.

Theſe are all the methods of proſecution at the ſuit of the king. There yet remains another, which is merely at the ſuit of the ſubject, and is called an Appeal. See that article.

But of all the methods of proſecution, that by indictment is the moſt general. See Indictment.

PROSECUTOR, in law, he that purſues a cauſe in another's name.

PROSELYTE, a new convert to ſome religion or religious ſect.

PROSERPINACA, in botany: A genus of the trigynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 15th order, *Inundatæ*. The calyx is tripartite ſuperior; there is no corolla; there is one trilocular ſeed.

PROSERPINE, in fabulous hiſtory, the daughter of Jupiter and Ceres, was carried off by Pluto as ſhe was gathering flowers with her companions. Ceres, diſconſolate for the loſs of her daughter, after having long ſought her, heard where ſhe was, and intreated Jupiter to let her return from hell. This requeſt Jupiter granted, on condition ſhe had taſted nothing in Pluto's dominions. Ceres therefore went to fetch her; but when her daughter was preparing to return, Aſcalaphus gave information that he had ſeen Proſerpine eat ſome grains of a pomegranate ſhe had gathered in Pluto's garden; on which ſhe was ſentenced to continue in Tartarus in quality of Pluto's ſpouſe, and the queen of thoſe gloomy regions: but to mitigate the grief of Ceres for her diſappointment, Jupiter granted that her daughter ſhould only ſpend ſix months together in hell with her huſband, and the other ſix on earth with her mother.

Some mythologiſts imagine that the latter part of the fable alludes to the corn, which muſt remain all the winter hid in the earth, in order to ſprout forth in the ſpring, and produce the harveſt.

PROSEUCHE, in antiquity, properly ſignifies *prayer;* but it is taken for the places of prayer of the Jews, and was pretty near the ſame as their ſynagogues. But the ſynagogues were originally in the cities, and were covered places: whereas, for the moſt part, the proſeuches were out of the cities, and on the banks of rivers; having no covering, except perhaps the ſhade of ſome trees or covered galleries. The word is Greek, προσευχη *prayer*.

PROSLAMBANOMENE, the name of a muſical note in the Greek ſyſtem.

As the two tetrachords of the Greeks were conjunctive, or, in other words, as the higheſt note of the firſt ſerved likewiſe for the loweſt note of the ſecond, it is plain that a complete octave could not be formed. To remedy this deficiency, therefore, one note beneath the loweſt tetrachord was added, as an octave to the higheſt of the laſt tetrachord. Thus, if we ſuppoſe the firſt to have begun on B, the laſt muſt have ended upon A, to which one note ſubjoined immediately beneath the loweſt B in the diatonic order muſt have formed an octave. This note was called *proſlambanomene*. But it appears from authors who have ſcrutinized antiquity with ſome diligence, and perhaps with as much ſucceſs as the data upon which they proceeded could produce, that the names of the notes in the Greek ſyſtem, which originally ſignified their natural ſtation in the ſcale of aſcending or deſcending ſounds, were afterwards applied to their poſitions in the lyre. *Higher* or *lower*, then, according to this application, did not ſignify their degrees of acuteneſs or gravity, but their higher or lower ſituation upon this inſtrument. *Burney's Hiſt. of Muſic, Diſſert. § 1.*

PROSODY, that part of grammar which treats of the quantities and accents of ſyllables, and the manner of making verſes.

The Engliſh proſody turns chiefly on two things, numbers and rhyme. See Poetry, n° 66—76. and Part III.

PROSOPIS, in botany: A genus of the monogynia order, belonging to the decandria claſs of plants. The calyx is hemiſpherical and quadridentate; the ſtigma is ſimple; the legumen inflated and monoſpermous.

PROSOPOPŒIA, a figure in oratory, whereby we raiſe qualities of things inanimate into perſons. See Oratory, p. 439 and 452.

PROSTATÆ, in anatomy, a gland, generally ſuppoſed to be two ſeparate bodies, though in reality but one, ſituated juſt before the neck of the bladder, and ſurrounding the beginning of the urethra. See Anatomy, p. 738. col. 2.

PROSTYLE, in architecture, a range of columns in the front of a temple.

PROTAGORAS, a famous Greek philoſopher, was born at Abdera. In his youth, his poverty obliged him to ſubmit to the ſervile office of frequently carrying logs of wood from the neighbouring fields to Abdera. It happened, that as he was one day going on briſkly towards the city under one of theſe loads, he was met by Democritus, who was particularly ſtruck with the neatneſs and regularity of the bundle. Deſiring him to ſtop and reſt himſelf, Democritus examined more cloſely the ſtructure of the load, and found that it was put together with mathematical exactneſs; upon which he aſked the youth whether he himſelf had made it up. Protagoras aſſured him that he had; and immediately taking it to pieces, with great eaſe replaced every log in the ſame exact order as before. Democritus expreſſed much admiration of his ingenuity; and ſaid to him, "Young man, follow me, and your talents ſhall be employed upon greater and better things." The youth conſented, and Democritus took him home, maintained him at his own expence, and taught him philoſophy, which qualified him for the office of legiſlator of the Thurians. He was more ſubtle than ſolid in his reaſonings; however, he taught at Athens with great reputation, but was at length *Enfield's Hiſtory of Philoſophy, Vol. I.*

length banished from thence for the impiety of his doctrines. He then travelled, and visited the islands in the Mediterranean, where it is said that he was the first philosopher who taught for money. He died in a voyage to Sicily, in a very advanced age. He commonly reasoned by dilemmas, and left the mind in suspense with respect to all the questions he proposed. His moral principles were adopted by Hobbes. (See MORAL PHILOSOPHY). Plato wrote a dialogue against him. He flourished 400 years B. C.

PROTASIS, in the ancient drama, the first part of a comic or tragic piece, wherein the several persons are shown, their characters intimated, and the subject of the piece proposed and entered upon.

It might reach as far as our two first acts; and where it ended the epitasis commenced. See the article EPITASIS.

PROTEA, the SILVER-TREE: A genus of the monogynia order, belonging to the tetrandria class of plants; and in the natural method ranking under the 47th order, *Stellatæ*. There is one quadrifid petal surrounding the germ; there is no proper calyx; the receptacle is paleaceous. There are 36 species, all natives of the Cape of Good Hope; of which the most remarkable are, 1. The conifera, with linear, spear-shaped, entire leaves, grows to the height of 10 or 12 feet, with a straight regular stem. The branches naturally form a large regular head. The leaves are long and narrow, of a shining silver colour; and as they remain the whole year, make a fine appearance in the greenhouse. 2. The argentea, commonly called *silver-tree*, has a strong upright stem covered with purplish bark, dividing into several branches which grow erect, garnished with broad, shining, silvery leaves, which make a fine appearance when intermixed with other exotics. Through the whole year it exhibits its glossy white or silvery leaves. It has at first a very uncommon and beautiful appearance, and sometimes in the course of 12 or 15 years reaches the height of 20 feet, which it never exceeds. In a rich soil it grows twice as quick, and is by far the largest of the protea kind. They are generally planted near some farms, and very seldom grow wild; Mr Sparman * thinks it was probably brought to the Cape of Good Hope from *Anamaqua*; for he had travelled over the whole north-east side of Hottentot's Holland, without finding it either in its wild state or planted. 3. The nitida, or wageboom, greatly resembles the second sort: the leaves are very silky and white, with erect purple branches.

* *Voyage to the Cape of Good Hope*, Vol. I. p. 33.

All these plants, being tender exotics, require to be continually kept in the greenhouse during winter. The first may be propagated by cuttings, which should be cut off in April, just before the plants begin to shoot; the second and third sorts may be propagated by seeds.

PROTECTOR, a person who undertakes to shelter and defend the weak, helpless, and distressed.

Every Catholic nation, and every religious order, has a protector residing at the court of Rome, who is a cardinal, and is called the *cardinal protector*.

Protector is also sometimes used for a regent of a kingdom, made choice of to govern it during the minority of a prince.

Cromwell assumed the title and quality of *lord protector of the commonwealth of England*, &c.

PROTESILAI TURRIS, the sepulchre of Protesilaus, with a temple, at which Alexander sacrificed, (Arian); situated at the south extremity of the Hellespont, next the Chersonesus Thracia. Protesilaus was the first Greek who landed on the coast of Troy, and the first Greek slain by the Trojans, (Homer, Ovid.) His wife Laodamia, to assuage her grief, begged the gods for a sight of his shade; and obtaining her request, she expired in his embraces, (Hyginus.) Protesilaus was also called *Phylacides*, from Phylace, a town of Thessaly.

PROTEST, in law, is a call of witness, or an open affirmation that a person does, either not at all, or but conditionally, yield his consent to any act, or to the proceeding of any judge in a court in which his jurisdiction is doubtful, or to answer upon his oath farther than he is bound by law.

Any of the lords in parliament have a right to protest their dissent to any bill passed by a majority: which protest is entered in form. This is said to be a very ancient privilege. The commons have no right to protest. See PARLIAMENT.

PROTEST, in commerce, a summons written by a notary-public to a merchant, banker, or the like, to accept or discharge a bill of exchange drawn on him, after his having refused either to accept or pay it. See *BILL of Exchange*.

PROTESTANT, a name first given in Germany to those who adhered to the doctrine of Luther; because in 1529 they protested against a decree of the Emperor Charles V. and the diet of Spires; declaring that they appealed to a general council. The same name has also been given to those of the sentiments of Calvin; and is now become a common denomination for all those of the reformed churches.

PROTEUS, in heathen mythology. See EGYPT, n° 6.

PROTHONOTARY, a term which properly signifies *first notary*, and which was anciently the title of the principal notaries of the emperors of Constantinople.

Prothonotary, with us, is used for an officer in the court of king's-bench and common-pleas; the former of which courts has one, and the latter three. The prothonotary of the king's-bench records all civil actions sued in that court, as the clerk of the crown-office does all criminal causes. The prothonotaries of the common pleas enter and enrol all declarations, pleadings, assizes, judgments, and actions: they also make out all judicial writs, except writs of *habeas corpus*, and *distringas jurator*, for which there is a particular office, called the *habeas corpora office*: they likewise enter recognizances acknowledged, and all common recoveries; make exemplifications of records, &c.

In the court of Rome there is a college of 12 prelates, called *apostolical prothonotaries*, empowered to receive the last wills of cardinals, to make all informations and proceedings necessary for the canonization of saints, and all such acts as are of great consequence to the Papacy: for which purpose they have the right of admission into all consistories, whether public or half public. They also attend on the pope, whenever he performs any extraordinary ceremony out of Rome.

PROTO, a Greek term, frequently used in composition of priority: thus, proto-collum, in the ancient

jurisprudence,

jurifprudence, fignifies the firft leaf of a book; proto-martyr, the firft martyr; proto-plaft, the firft man formed, &c.

PROTOGENES, a celebrated ancient painter, was born at Caunas, a city of Caria, fubject to the Rhodians, and flourifhed 300 years before the birth of our Saviour. He was at firft obliged to paint fhips for his livelihood; but afterwards acquired the higheft reputation for hiftory-painting; though Apelles blamed him for finifhing his pieces too highly, and not knowing when to have done. The fineft of his pictures was that of Jalifus, which is mentioned by feveral ancient authors, though none of them give any defcription of it. He worked feven years on this picture; during which time he lived entirely upon lupines and water, being of opinion that this light and fimple nourifhment left him greater freedom of fancy. Apelles, on feeing this picture, was ftruck with fuch admiration, that he was unable to fpeak, or to find words fufficient to exprefs his idea of its beauty. It was this picture that faved the city of Rhodes when befieged by Demetrius king of Macedon; for being able to attack it only on that fide where Protogenes worked, which he intended to burn, he chofe rather to abandon his defign than to deftroy fo fine a piece. Pliny fays, that Apelles afking him what price he had for his pictures, and Protogenes naming an inconfiderable fum, Apelles, concerned at the injuftice done to the beauty of his productions, gave him 50 talents, about 10,000 l. for one picture only, declaring publicly that he would fell it for his own. This generofity made the Rhodians fenfible of the merit of Protogenes; and they were fo eager to purchafe the picture Apelles had bought, that they paid him a much greater price for it than he had given.

PROTOTYPE, is the original or model after which a thing was formed; but chiefly ufed for the patterns of things to be engraved, caft, &c.

PROTRACTOR, an inftrument for laying down and meafuring angles upon paper with accuracy and difpatch; and by which the ufe of the line of chords is fuperfeded. This inftrument is varioufly formed, as femicircular, rectangular, or circular; and conftructed of different materials, as brafs, ivory, &c. It is neceffary in laying down thofe furveys or other plans where angles are concerned. For the femicircular protractor, and its ufe in laying down and meafuring angles, fee GEOMETRY, p. 676. prop. xx. &c.

The rectangular protractor is conftructed in form of a right-angled parallelogram, which, when applied to a cafe of mathematical inftruments, is fubftituted in place of the femicircular protractor and fcale of equal parts. Fig. 1. is a reprefentation of it: the manner of ufing it is exactly fimilar to that of the femicircular one.

The circular protractor, as its name implies, is a complete circle, and is fuperior by far to either of the former, both in point of accuracy and difpatch, efpecially when feveral angles are to be formed at the fame point. The limb of this inftrument is divided into 360 degrees, and each degree in fome protractors is halved: it has a fubdividing fcale or vernier, by which an angle may be laid down or meafured to a fingle minute. In the centre of the protractor is a fine mark, which, when an angle is to be protracted or meafured, is to be laid upon the angular point, and o, or zero on the limb, upon the given line forming one fide of the angle.

Protractor.

Fig. 2. reprefents a circular protractor whofe limb is divided as above defcribed, and the dividing fcale on the index, which moves round the limb of the protractor on a conical centre, gives every minute of a degree. That part of the index beyond the limb has a fteel point fixed at the end, in a direct line with the centre of the protractor, and whofe ufe is to prick off the propofed angles.

Fig. 3. is another circular protractor, a little differently conftructed from the former. The central point is formed by the interfection of two lines croffing each other at right angles, which are cut on a piece of glafs. The limb is divided into degrees and half degrees, having an index with a vernier graduated to count to a fingle minute, and is furnifhed with a tooth and pinion, by means of which the index is moved round by turning a fmall nut. It has two pointers, one at each end of the index, furnifhed with fprings for keeping them fufpended while they are bringing to any angle; and being brought, applying a finger to the top of the pointer, and preffing it down, pricks off the angle. There is this advantage in having two pointers, that all the bearings round a circuit may be laid or pricked off, although the index traverfes but one half of the protractor.

Another circular protractor, different from either of the former, is reprefented at fig. 4. The centre is alfo formed by the interfection of two lines at right angles to each other, which are cut on glafs, that all parallax may thereby be avoided. The index is moved round by a tooth and pinion. The limb is divided into degrees and half degrees, and fubdivided to every minute by the vernier. The pointer may be fet at any convenient diftance from the centre, as the focket which carries it moves upon the bar BC, and is fixed thereto by the nut D, at right angles to the bar BC, and moveable with it. There is another bar EF: On this bar different fcales of equal parts are placed; fo that by moving a fquare againft the inner edge thereof, angles may be transferred to any diftance within the limits, from the centre containing the fame number of degrees marked out by the index.

It would indeed be fuperfluous to defcribe any more of thefe circular protractors, efpecially as the little alterations in them depend very much upon the fancy of the artift. Suffice it however to fay, that we have feen others ftill differently conftructed, one of which we fhall briefly defcribe. The divifions upon the limb of this inftrument are fimilar to thofe already defcribed; but the index is a ftraight bar continued to fome confiderable diftance each way beyond the limb of the inftrument, and has a vernier to fhow minutes as ufual; a mark upon one of the edges of the index always coincides with the centre of the inftrument. Inftead, therefore, of pricking down the angle as in the former, part of the line containing the angle may be drawn, which, although perhaps not fo accurate as a point, is more confpicuous, and the line is eafily completed upon removal of the protractor. The common dimenfions of the circular part of thefe inftruments is from fix to ten inches diameter; and they are made of brafs.

PROTUBERANCE,

Protuberance || Providence.

PROTUBERANCE, in anatomy, is any eminence, whether natural or preternatural, that projects or advances out beyond the rest.

PROVEDITOR, an officer in several parts of Italy, particularly at Venice, who has the direction of matters relating to policy.

PROVENCE, a province or government of France, bounded by Dauphine on the north, by Piedmont on the east, by the Mediterranean on the south, and by the river Rhone, which separates it from Languedoc, on the west: it is about 100 miles long, and near as many broad.

PROVEND, or PROVENDER, originally signified a kind of vessel containing the measure of corn daily given to a horse, or other beast of labour, for his subsistence; but is now generally used to signify the food for cattle, whatever it is.

PROVERB, according to Camden, is a concise, witty, and wise speech, grounded upon experience, and for the most part containing some useful instruction.

Book of PROVERBS, a canonical book of the Old Testament, containing a part of the proverbs of Solomon the son of David king of Israel. The first 24 chapters are acknowledged to be the genuine work of that prince; the next five chapters are a collection of several of his proverbs made by order of king Hezekiah; and the two last seem to have been added, though belonging to different and unknown authors, Agur the son of Jakeh, and king Lemuel.

In this excellent book are contained rules for the conduct of all conditions of life; for kings, courtiers, masters, servants, fathers, mothers, children, &c.

1 Definition.

PROVIDENCE, the superintendance and care which God exercises over creation.

2 Belief of a providence universal.

That there exists a divine providence which attends to the affairs of this world, and directs their course, has been a received opinion among the human race in every country and in every period of history. Every altar that is erected, every prayer and every sacrifice that is offered up, affords a proof of this belief. So fully have men been convinced of the sincerity of each other's faith upon this subject, that in one form, that of an appeal to the Divine Ruler of the world, by the solemnity of an oath, they have introduced it both into the most ordinary and the most important business of life.

3 Existence of providence may be proved on scientific principles.

This universal conviction of men of all degrees of knowledge, from the most profound philosopher to the rudest barbarian, is probably to be traced to some primæval tradition, never totally effaced from any nation under heaven. The truth itself, however, is susceptible of the most complete proof from principles of science. If the world had a beginning, it may obviously have an end, and can be continued in existence only by the constant energy of that power by which it was at first created. He therefore who acknowledges a creation and denies a providence, involves himself in this palpable contradiction—" that a system, which of itself had not an original and momentary existence, may yet of itself have a perpetual existence; or that a being which cannot of itself exist for a second of time, may yet, of itself, exist for thousands of years!" Or should we be so complaisant, as for a moment to suppose, with certain theists, ancient and modern, that the *matter* of the universe is self-existent and eternal, and that the power of God was exerted, not in creating substances, but in reducing the original matter from a state of chaos into that beautiful order in which we see it arranged; the constant energy of providence must still be admitted as necessary to preserve the forms and to continue the motions which were originally impressed upon the chaotic mass. From late experiments it appears extremely doubtful whether any two atoms of the most solid body be in actual contact; and that they are not *all* in contact is certain. (See METAPHYSICS, n° 176. and OPTICS, n° 46, 64, 66.) Yet it requires a very considerable degree of force to carry to a greater distance from one another the parts of a stone or of a bar of iron. By what power then are these parts kept contiguous? It cannot be by their own; because nothing can act where it is not present, and because our best philosophy has long taught us that the atoms of matter are essentially inactive. Again, it requires a very great degree of force to bring two bodies, however small, into *apparent* contact (see OPTICS, *ubi supra*); and therefore it follows that they must be kept asunder by some foreign power. Every attempt to solve these phenomena by the intervention of a subtle fluid is vain; for the question recurs, what keeps the parts of the fluid itself contiguous, and yet separated from each other?

The cohesion therefore of the parts of matter, and that which is called their repulsive power, demonstrate, through the whole system, the immediate energy of something which is not matter, and by which every body small and great is preserved in its proper form. It has been elsewhere shown (see METAPHYSICS, Part II. chap. 5. and MOTION, n° 19, 20.), that the various motions which are regularly carried on through the universe, by which animals and vegetables grow and decay, and by which we have day and night, summer and winter, cannot be accounted for by any laws of mere mechanism, but necessarily imply the constant agency of something which is itself distinct from matter. But the forms of bodies are preserved, and their natural motions carried on, for purposes obviously planned by Wisdom. The power therefore which effects these things must be combined with intelligence: but power and intelligence preserving the order of the universe constitute all that is meant by a general providence; which is therefore as certainly administered as the sun daily rises and sets, or as bodies are kept solid by what is termed cohesion and repulsion.

Rea[soning] of t[he] min[ds of] Hin[dostan].

Abstracted and metaphysical as this reasoning may appear, it is by no means peculiar to the philosophers of Europe. Its force has been felt from time immemorial by the Bramins of Hindostan, who, as Sir William Jones informs us*, " being unable to form a distinct idea of brute matter independent of mind, or to conceive that the work of supreme goodness was left a moment to itself, imagine that the Deity is ever present to his work, not in substance but in spirit and in energy." On this rational and sublime conception they have indeed built numberless absurd superstitions; but their holding the opinion itself, shows that they believe in the reality of providence upon philosophical principles: and what truth is there on which the mind of man has not ingrafted marks of its own weakness?

* A[siat.] Rese[arches] Vol.

Few nations, however, except the ancient Greeks, have had philosophers equally subtile with the Bramins

 of

of India; and therefore though all mankind have in general agreed in the belief of a ſuperintending Providence, they have in different ages and countries admitted that truth upon different kinds of evidence, and formed very different notions concerning the mode in which the Divine ſuperintendence is exerted.

While ſocieties are ſtill in a rude and unpoliſhed ſtate, while individuals poſſeſs little ſecurity and little leiſure for the exertion of their rational powers, every important or ſingular appearance in nature becomes an object of wonder or of terror. In this ſtate of ignorance, men ſee not the univerſe as it is, a great collection of connected parts, all contributing to form one grand and beautiful ſyſtem. Every appearance ſeems to ſtand alone; they know that it muſt have a cauſe, but what that cauſe is they are ignorant. The phenomena exhibited by nature are ſo complicated and ſo various, that it never occurs to them that it is poſſible for one Being to govern the whole. Hence aroſe the different ſyſtems of polytheiſm that have appeared in the world. Nature was divided into different regions, and a particular inviſible power was aſſigned to each department: one conducted the flaming chariot of the ſun, another wielded the terrible thunderbolt, and others were employed in diffuſing plenty, and introducing the uſeful arts among men. Thus, although the various ſyſtems of polytheiſm in general acknowledged one Supreme Ruler, the father of gods and men, yet they at the ſame time peopled not only the regions above, the air and the heavens, but they alſo filled the ocean and the land, every grove, and every mountain, with active but inviſible natures. Having ariſen from the ſame cauſes, theſe ſyſtems of polytheiſm, which are ſo many hypotheſes concerning Divine providence, are all extremely ſimilar; and we have a very favourable ſpecimen of them in the elegant mythology of Greece and Rome, which gave to every region of nature a guardian genius, and taught men in the deep receſſes of the foreſt, or in the windings of the majeſtic flood, to expect the preſence of protecting and friendly powers. See POLYTHEISM.

Notwithſtanding this univerſal reception, in ſome form or other, of the doctrine of a divine providence, it has in every age met with ſome opponents. The moſt ancient of theſe were Democritus and Leucippus. They denied the exiſtence of a Deity—aſſerted that all things were mechanically neceſſary, and that thought and ſenſe were only modifications of matter. This is atheiſm in the ſtricteſt ſenſe, and the only form of it that has ever been conſiſtently ſupported. Epicurus followed upon the ſame principles; but he rendered the ſyſtem altogether abſurd, by confeſſing the freedom of the human will. To avoid the imputation of atheiſm, he aſſerted the exiſtence of God; but declared that he reſided above the heavens, and interfered not in human affairs. One of his maxims was, that "the bleſſed and immortal Being neither hath any employment himſelf, nor troubles himſelf with others." Maximus Tyrius * juſtly obſerves, that this is rather a deſcription of a Sardanapalus than of a Deity. And ſome of the moraliſts † of antiquity remarked, that they knew many men among themſelves poſſeſſed of active and generous minds, whoſe characters they valued more highly than that of Epicurus's god. Some of the ancients alſo appear to have entertained the following ſtrange notion: They acknowledged the exiſtence of a Supreme and of many inferior deities; but at the ſame time, they ſuppoſed that there is a certain fate which rules over all, and is ſuperior to the gods themſelves. See *NECESSITY* in Mythology.

The providence exerted by the Author of nature over his works is uſually divided into two branches: a *general*, referring to the management of the univerſe at large; and a *particular* providence, chiefly regarding particular men.

7 General providence,

Upon the firſt of theſe, in *The Religion of Nature delineated*, the queſtion is ſtated ſomewhat in the following manner: The world may be ſaid to be governed, or at leaſt cannot be ſaid to fluctuate fortuitouſly, if there are laws or rules by which natural cauſes act; if the ſeveral phenomena in it ſucceed regularly, and in general the conſtitution of things is preſerved; if there are rules obſerved in the production of herbs, trees, and the like; if the ſeveral kinds of animals are furniſhed with faculties proper to determine their actions in the different ſtations which they hold in the general economy of the world; and, laſtly, if rational beings are taken care of in ſuch a manner as will at laſt agree beſt with reaſon. By the providence of God we ought to underſtand his governing the world by *ſuch* laws as theſe now mentioned: ſo that if there are ſuch, there muſt be a Divine providence.

8 As it reſpects inanimate objects,

With regard to *inanimate objects*, the caſe agrees preciſely with the above ſuppoſition. The whole of that univerſe which we ſee around us is one magnificent and well regulated machine. The world that we inhabit is a large globe, which, conducted by an inviſible power, flies with a rapidity of which we have no conception, through an extent of ſpace which ſets at defiance every power of fancy to embody it into any diſtinct image. A large flaming orb ſtands immoveable in the heavens; around which this, and other worlds of different magnitudes, perform their perpetual revolutions. Hence ariſe the expected returns of day and night, and the regular diverſity of ſeaſons. Upon theſe great operations a thouſand other circumſtances depend. Hence, for example, the vapours aſcend from the ocean, meet above in clouds, and after being condenſed, deſcend in ſhowers to cover the earth with fertility and beauty. And theſe appearances are permanent and regular. During every age ſince men have been placed upon the earth, this aſtoniſhing machine continued ſteadily to perform its complicated operations. Nothing is left to chance. The ſmalleſt bodies are not leſs regular than the largeſt, and obſerve continually the ſame rules of attraction, repulſion, &c. The apparent variations of nature proceed only from different circumſtances and combinations of things, acting all the while under their ancient laws. We ourſelves can calculate the effects of the laws of gravitation and of motion. We can render them ſubſervient to our own purpoſes, with entire certainty of ſucceſs if we only adhere to the rules eſtabliſhed by nature, that is to ſay, by providence.

9 Vegetables,

Vegetables alſo live and flouriſh according to preſcribed methods. Each ſort is produced from its proper ſeed; has the ſame texture of fibres, is at all times nouriſhed by the *ſame* kind of juices, digeſted and prepared by the *ſame* veſſels. Trees and ſhrubs receive annually their peculiar liveries, and bear their proper fruits: ſo regular are they in this laſt reſpect, that every ſpecies may be ſaid to have its profeſſion or trade appointed

Providence

pointed to it, by which it furniſhes a certain portion of manufacture, or of food, to ſupply the wants of animals: being created for the purpoſe of conſumption, all vegetables produce great quantities of ſeed to ſupply the neceſſary waſte. Here too, then, there is evidently a *regulation* by which the ſeveral orders are preſerved, and the ends of them anſwered according to their firſt eſtabliſhment.

10 Animals,

With regard to *animals*, they too, in ſtructure of their form, are ſubject to laws ſimilar to thoſe which govern the vegetable world. In the ſentient part of their conſtitution they are no leſs ſubject to rule. The lion is always fierce, the fox is crafty, and the hare is timid. Every ſpecies retains from age to age its appointed place and character in the great family of nature. The various tribes are made and placed in ſuch a manner as to find proper means of ſupport and defence. Beaſts, birds, fiſhes, and inſects, are all poſſeſſed of organs and faculties adapted to their reſpective circumſtances, and opportunities of finding their proper food and prey.

11 And man.

Man is ſubject to the ordinary laws which other material and animal ſubſtances obey; but he is left more at large in the determination of his actions. Yet even here things do not fluctuate at random. Individuals do indeed riſe and periſh according to fixed rules, and nations themſelves have only a temporary endurance. But the ſpecies advances with a ſteady progreſs to intellectual improvement. This progreſs is often interrupted; but it appears not to be leſs ſure at the long-run than even the mechanical laws which govern the material part of our conſtitution. Amidſt the convulſion of ſtates and the ruin of empires, the uſeful arts, when once invented, are never loſt. Theſe, in better times, render ſubſiſtence eaſy, and give leiſure for reflection and ſtudy to a greater number of individuals. Tyre and Sidon have paſſed away, Athens itſelf has become the prey of barbarians, and the proſperity of ancient Egypt is departed, perhaps for ever; but the ſhip, the plow, and the loom, remain, and have been perpetually improving. Thus every new convulſion of ſociety does leſs miſchief than the laſt; and it is hoped that by the aſſiſtance of printing the moſt poliſhed arts and the moſt refined ſpeculations have now become immortal.

The world is not then left in a ſtate of confuſion: it is reduced into order, and methodiſed for ages to come; the ſeveral ſpecies of beings having their offices and provinces aſſigned them. Plants, animals, men, and nations, are in a ſtate of continual change; but ſucceſſors are appointed to relieve them, and to carry on the *ſcheme of Providence*.

12 Difficulty of accounting for particular providence.

But the great difficulty is, how to account for that providence which is called *particular*: For rational beings, and free agents, are capable of doing and deſerving well or ill; and the ſafety or danger, that happineſs or unhappineſs, of a man here, muſt depend upon many things that ſeem ſcarcely *capable* of being determined by Providence. Beſides *himſelf* and his own conduct, he depends upon the conduct of *other men;* whoſe actions, as we naturally ſuppoſe, cannot, conſiſtently with their free will, be controuled for the advantage of another individual. The actions of numbers of men proceeding upon their private freedom, with different degrees of ability, as they croſs and impede, or directly oppoſe each other, muſt produce very different effects upon men of different characters, and thus in a ſtrange manner embarraſs and entangle the general plan. And as to the *courſe of nature*, it may juſtly be aſked, is the force of gravitation to be ſuſpended till a good man paſs by an infirm building? (See Prayer.) Add to this, that ſome circumſtances appear abſolutely irreconcileable. The wind which carries one into port drives another back to ſea; and the rains that are juſt ſufficient upon the hills may drown the inhabitants of the valleys. In ſhort, may we expect *miracles?* or can there be a particular Providence that foreſees and prepares for the ſeveral caſes of individuals, without force frequently committed upon the laws of nature and the freedom of intelligent agents?

13 No goo[d] argume[nt] againſt exiſtenc[e]

In whatever way it is brought about, there is little doubt that ſomething of this kind *muſt* take place. For as the Deity *does* direct, as already mentioned, the great and general progreſs of things in this world, he muſt alſo manage thoſe of leſs importance. Nations are compoſed of individuals. The progreſs of individuals is the progreſs of the nation, and the greateſt events uſually depend upon the hiſtory and the moſt trifling actions of private perſons. The difficulty is to conceive how the ſuperintendence and management of all this can be brought about. But as the ways and the thoughts of the Omnipotent Spirit, whoſe influence pervades, and rules, and animates nature, reſemble not the limited operations of men, we can only form conjectures concerning the means by which his government is conducted.

14 The D[ei]ty may [ea]ſily fore[see] the acti[ons] of men

1. In the firſt place, then, it is not impoſſible that the Deity ſhould foreſee the future actions of intelligent beings. Many of theſe actions depend upon the mechaniſm of the material world, which was formed by himſelf, and muſt be entirely known to him. Many men among ourſelves poſſeſs much ſagacity in diſcerning the future actions of others, from attending to their known characters, and the circumſtances in which they are placed. If ſuperior natures do exiſt, and minds more perfect than the human, they muſt poſſeſs this penetration in a more eminent degree in proportion to the excellence of their intellectual powers. But if this diſcernment be in God proportionable to his nature, as in lower beings it is proportionable to theirs, it then becomes altogether unlimited, and the future actions of free agents are at once unlocked and expoſed to his view. Add to this, that the Author of nature is well acquainted with the creatures that he has made; he knows the mechaniſm of our bodies, the nature and extent of our underſtandings, and all the circumſtances by which we are ſurrounded. With all theſe advantages, it is making no great ſtretch to ſuppoſe him capable of diſcerning the line of conduct which we will purſue; and this even ſetting aſide the infinity of his nature, to which a thouſand years are as one day, and ſuppoſing him to reaſon from probabilities in the imperfect manner that we do.

15 And m[ay] thence [fit] them f[or] their ſit[ua]tions in life.

2. There is no impoſſibility at leaſt, that men, whoſe characters and actions are thus foreknown, may be introduced into the world in ſuch times and places as that their acts and behaviour may not only coincide with the general plan of things, but may alſo anſwer many private caſes. The celeſtial bodies are ſo placed that their jarring attractions make out a ſplendid ſyſtem.

Why

idence

Why then may there not be in the Divine mind something like a projection of the future history of mankind, as well as of the motions of the heavenly bodies? And why should it not be thought possible for men, as well as for them, by some secret law, or rather by the management of an unseen power, to be brought into their places in such a manner as that, by the free use of their faculties, the conjunctions and oppositions of their interests and inclinations, the natural influence of their different degrees of talents, power, and wealth, they may conspire to make out the great scheme of human affairs? There is no absurdity in this supposition: it is not beyond the power of an almighty and perfect Being; and it is worthy of him. Let us take from the Jewish history, as most generally known, an example of what may be supposed to happen daily. It was the intention of providence to place David the son of Jesse upon the throne of the Hebrews. The country is invaded by a foreign enemy: the hostile armies meet, and lie encamped upon opposite mountains. A man comes forth from the army of the invaders, as was extremely common in those times, and defies the Hebrew host to send forth a champion to meet him in single combat. Terrified by the gigantic bulk and mighty force of Goliah, no man would risk the unequal conflict. David, who was too young to carry arms, had been sent to the camp with provisions for his brothers, and heard the challenge. In defence of his flock he had killed some beasts of prey in the wilderness, and he was an excellent marksman with the sling. He thought it might probably be as easy to kill a man as a wild beast; at all events, he knew that a stone well directed would prove no less fatal to a giant than to a dwarf: he therefore resolved to try his skill; and he tried it with success. Here no man's free will was interrupted, and no miracle was accomplished: Yet by this *train* of circumstances thus *brought* together, a foundation was laid for the future fortunes of the son of Jesse, for the greatness of his country, and for accomplishing the purposes of Providence. According to Seneca, "Hoc dico, fulmina non mitti a Jove, sed sic omnia disposita, ut ea etiam quæ ab illo non fiunt, tamen sine ratione non fiunt: quæ illius est.—Nam etsi Jupiter illa nunc non facit, fecet ut fierent."—*I say, that the lightning comes not directly from the hand of Jove, but things are properly disposed for the indirect execution of his will; for he acts not immediately, but by the intervention of means.*

16 possi- y of exem- ed.

17 ect in- nces on mind far n im- ible.

3. Lastly, it is *not impossible* that many things may be accomplished by secret influence, upon the human mind, either by the Deity himself, or by the intervention of agents possessed of powers superior to those which belong to us. "For instance, if the case should require that a particular man be delivered from some threatening *ruin*, or from some *misfortune*, which would certainly befal him if he should go such a way at such a time, as he intended: upon this occasion some *new* reasons may be presented to his mind why he should not go *at all*, or not *then*, or not *by that road*; or he may forget to go. Or, if he is to be delivered from some dangerous *enemy*, either some new turn given to his thoughts may divert him from going where the *enemy* will be, or the enemy may be after the same manner diverted from coming where *he* shall be, or his resentment may be *qualified*; or some proper method of *defence* may be suggested to the person in danger. After the same manner advantages and successes may be conferred on the deserving; as, on the other side, men, by way of punishment for their crimes, may incur mischiefs and calamities. These things, and such as these (says Mr Wollaston *), *may be*. For since the motions and actions of men, which depend upon their wills, do also depend upon their judgments, as these again do upon the *present appearances* of things in their minds; if a new prospect of things can be any way produced, the lights by which they are seen *altered*, new forces and directions impressed upon the spirits, passions *exalted* or *abated*, the power of judging *enlivened* or *debilitated*, or the attention taken off without any suspension or alteration of the standing laws of nature,—then, without that, *new* volitions, designs, measures, or a cessation of thinking, may also be produced; and thus many things prevented that otherwise would *be*, and many brought about that would *not*. That there may possibly be such inspirations of new thoughts and counsels (continues our author), may perhaps appear farther from this, that we frequently find thoughts arising in our heads, into which we are led by no discourse, nothing we read, no clue of reasoning, but they surprise and come upon us from we know not what quarter. If they proceeded from the mobility of spirits straggling out of order, and fortuitous affections of the brain, or were they of the nature of *dreams*, why are they not as wild, incoherent, and extravagant as they are?" Is it not much more reasonable to imagine that they come by the order and direction of an all-seeing and all-gracious God, who continually watches over us, and disposes every thing in and about us for the good of ourselves or others? not to speak of the agreeableness of this notion to the opinions of the best and wisest men in all ages (A). "If this, then, be the case, as it seems to be, that mens minds are susceptible of such *insinuations* and *impressions*, as frequently, by ways unknown, do affect them, and give them an inclination towards this or that; how many things (asks our author) may be brought to pass by these means without *fixing* and *unfixing* the laws of nature, any more than they are unfixed when one man alters the opinion of another by throwing in his way a book proper for that purpose?"

* *Religion of Nature delineated*, sect. 5.

18 And may be effected by beings superior to us, or by the Deity.

All this may be effected either by the immediate interposition of God himself, or by that of beings *invisible*, and in nature superior to us, who act as the ministers of his providence. That there are such beings we can hardly doubt, as it is in the highest degree improbable that such imperfect beings as men are at the top of the scale of created existence. And since we ourselves, by the use of our limited powers, do often alter the course of

(A) That such was the general belief of the Greeks in the days of Homer, is plain from that poet's constantly introducing his deities into the narrative of his poems, and telling us that Minerva, or some other god, altered the minds of his heroes. "By this," says Plutarch, "the poet does not mean to make God *destroy* the will of man, but only move him to will: nor does he miraculously produce the appetites themselves in men, but only causes such imaginations as are capable of exciting them."

Providence

of things within our sphere from what they would be if left to the ordinary laws of motion and gravitation, without being said to alter those laws; why may not superior beings do the same as instruments of divine providence? This idea of the intervention of superior natures is beautifully illustrated by Thomson in the following passage:

> These are the haunts of meditation, these
> The scenes where ancient bards th'inspiring breath,
> Ecstatic, felt; and from this world retir'd,
> Convers'd with angels and immortal forms,
> On gracious errands bent: to save the fall
> Of virtue struggling on the brink of vice;
> In waking whispers, and repeated dreams,
> To hint pure thought, and warn the favour'd soul
> For future trials fated to prepare.

We agree, however, with Mr Wollaston, in thinking the power of these beings not so large as to alter or suspend the general laws of nature (see MIRACLE); for the world is not like a bungling piece of clock-work, which requires to be often set backwards or forwards. We are likewise perfectly satisfied, that they cannot change their condition, to ape us or inferior beings; and consequently we are not apt hastily to credit stories of *portents*, &c. such as cannot be true, unless the nature of things and their manner of existence were occasionally reversed. Yet as men may be so placed as to become, even by the free exercise of their own powers, *instruments* of God's particular providence to other men; so may we well suppose that these higher beings may be so *distributed* through the universe, and subject to such an economy, unknown to us, as may render *them also* instruments of the same providence; and that they may, in proportion to their greater abilities, be capable, *consistently with the laws of nature*, of influencing human affairs in proper places.

19 Objections to the doctrine of Providence

We shall next proceed to state some of the chief objections which in ancient or modern times have been brought against the opinion, that the world is governed by a Divine providence.

20 From the imperfections of nature,

1. The first of these is this, that the system of nature contains many imperfections which it ought not to do if it be the work of a perfectly wise and good Being. To avoid the force of this objection, some modern writers have deserted the ground of supreme and absolute goodness, which the ancient theists always occupied, and have asserted that the divine perfection consists in unlimited power and uncontrouled supremacy of will; that consequently the Deity does not always that which is best, but merely what he himself pleases; and that for no other reason but because he *wills* to do so. But this is no better than atheism itself. For it is of no importance to us whether the universe is governed by blind fate or chance, that is to say, by nothing at all; or whether it is governed by an arbitrary sovereign will that is directed by chance, or at least by no principle of beneficence.

21 Answered.

The true answer to this objection is, that no created system can have every perfection, because it must necessarily be destitute of self-existence and independence; and therefore if beings destitute of some perfections be better than nothing, it was worthy of infinite power and perfect goodness to create such beings. In our present state, we mortals stand upon too low ground to take a commanding view of the whole frame of things. We can only reason concerning what is unknown from the little that is within our reach. In that little, we can see that wisdom and goodness reign; that nature always aims to produce perfection; that many salutary effects result even from the thunder and the storm: and we doubt not that a view of the whole structure of the universe would afford an additional triumph to the goodness and skill of its great Architect.

We see a regular ascent in the scale of beings from mere lifeless matter up to man; and the probability is, that the scale continues to ascend as far above man in perfection as created beings can possibly be raised.—The sole purpose of God in creating the world must have been to produce happiness: but this would be most effectually done by creating, in the first place, as many of the most perfect class of beings as the system could contain; and afterwards other classes less and less perfect, till the whole universe should be completely full. We do not positively assert such a scheme of creation,

> Where all must full, or not coherent be;
> And all that rises, rise in due degree,

was actually in the divine Architect's intention; but that it is possible, is sufficiently obvious. No man will pretend to say, that this earth could afford a comfortable subsistence to a greater number of the human race, were all the inferior animals annihilated, than it could at present, swarming as every element is with life.—Suppose then, that as many men had been placed at first upon the earth as it could possibly support, and that matters had been so constituted, as that the number should never have been either increased or diminished; we beg leave to ask, whether, since there would have been evidently room for inferior animals, it would have been most worthy of infinite goodness to leave the whole globe to men, or to introduce into it different orders of less perfect beings, which, while they could not incommode this principal inhabitant, would each find pleasure in its own existence? To this question different answers cannot surely be given. Let the reader then extend his view, and consider the universe, which, however vast, cannot be positively infinite, as one system as much united as the several parts of this globe; let him suppose that there were at first created as many of the highest order of beings as it could have contained had creation there stopt; let him remember that happiness in many different degrees is valuable;—and he will not surely think it any imputation on the goodness of God, that there are in the universe many beings far from perfection. The most imperfect of these are by themselves better than nothing; and they all contribute to make up a system which, considered as a whole, we have every reason to believe to be as perfect as any thing not self-existent can possibly be.

22 Objection from the introduction of

2. If the world is conducted by a benevolent providence, how came evil to be introduced into it? This question has perplexed mankind in all ages. The ancient Persians resolved it, by asserting the existence of two gods, Oromasdes the author of good, and Arimanius the author of evil. From them the Christian heretics called *Manichees* borrowed their doctrine of two

5 opposite

Providence opposite co-eternal principles. Both the Platonists and Stoics ascribed the origin of evil to the perverseness or imperfection of matter, which they thought the Deity could not alter; and Pythagoras imagined a state of pre-existence, in which the souls of men had committed offences, for which they are here suffering the punishment. But these hypotheses are, some of them impious, and all unsatisfactory.

23
[An]swered.

Taking the expression in its most extensive sense, the evils to which the human race are exposed may be reduced to *pain*, *uneasiness*, *disappointment of appetites*, and *death*; of which not one could have been wholly prevented without occasioning greater evils, inconsistent with the perfect goodness of the Creator. As long as we have solid bodies capable of motion, supported by food, subject to the influence of the atmosphere, and divisible, they must necessarily be liable to dissolution or death: But if a man could suffer death, or have his limbs broken, without feeling pain, the human race had been long ago extinct. A fever is a state of the body in which the fluids are in great disorder. Felt we no uneasiness from that disorder, we should have no inducement to pay the proper attention to our state, and should certainly die unawares, without suspecting ourselves to be in danger; whereas, under the present administration of divine providence, the pain and sickness of the disease compel us to have recourse to the remedies proper for restoring us to soundness and to health. Of the uneasinesses to which we are liable, and which are not the effect of immediate pain, the greatest has been sometimes said to arise from the apprehension of death, which constantly stares us in the face, and frequently embitters all our pleasures even in the hour of perfect health.—But this dread of death is implanted in our breasts for the very best of purposes. Had we no horror at the apprehension of death, we should be apt, whenever any misfortune befel us, to quit this world rashly, and rush unprepared into the presence of our Judge: but the horror which attends our reflections on our own dissolution, arising not from any apprehensions of the pain of dying, but from our anxiety concerning our future state of existence, tends strongly to make us act, while we are here, in such a manner as to ensure our happiness hereafter. Add to this, that the fear of death is the greatest support of human laws. We every day see persons breaking through all the regulations of society and good life, notwithstanding they know death to be the certain consequence, and feel all the horrors of it that are natural to man: and therefore were death divested of these horrors, how insignificant would capital punishments be as guardians of the law, and how insecure would individuals be in civil society?

With regard to the unavoidable misfortunes and anxieties of our present state, so far from being truly hurtful in themselves, they are proofs of divine beneficence. When we see men displeased with their situation, when we hear them complain of the difficulties, the miseries, and the cares of life, of the hardships which they have undergone, and the labours which still lie before them; instead of accounting them unfortunate, we ought to regard them as active beings, placed in the only situation that is fit for the improvement of their nature. That discontent, these restless wishes to improve their condition, are so many sure indications that their faculties will not languish. They who are in the least degree accustomed to observe the human character, know well the influence which pleasure and repose have in enfeebling every manly principle, and how capable they are of attaching us even to a sordid and dishonourable existence.

Happy indeed it is for the human race, that the number of those men is small whom providence has placed in situations in which personal activity is unnecessary. By far the greater number are compelled to exert themselves, to mix and to contend with their equals, in the race of fortune and of honour. It is thus that our powers are called forth, and that our nature reaches its highest perfection. It is even perhaps a general truth, that they who have struggled with the greatest variety of hardships, as they always acquire the highest energy of character, so if they have retained their integrity, and have not sunk entirely in the contest, seldom fail to spend their remaining days respectable and happy, superior to passion, and secured from folly by the possession of a wisdom dearly earned. 24

Physical evil the cause of moral good.

But the benefits of physical evils have been set in a still stronger light by a great master of moral wisdom, who was himself subject to many of those evils. That man is a moral agent, sent into this world to acquire habits of virtue and piety to fit him for a better state, is a truth to which no consistent theist will for a moment refuse his assent. But almost all the moral good which is left among us, is the apparent effect of physical evil.

Johnson's Idler, n° 89.

"Goodness is divided by divines into soberness, righteousness, and godliness. Let it be examined how each of these duties would be practised if there were no physical evil to enforce it.

"Sobriety or temperance is nothing but the forbearance of pleasure; and if pleasure was not followed by pain, who would forbear it? We see every hour those in whom the desire of present indulgence overpowers all sense of past, and all foresight of future misery. In a remission of the gout, the drunkard returns to his wine, and the glutton to his feast; and if neither disease nor poverty were felt or dreaded, every one would sink down in idle sensuality, without any care of others, or of himself. To eat and drink, and lie down to sleep, would be the whole business of mankind.

"Righteousness, or the system of social duty, may be subdivided into justice and charity. Of justice, one of the heathen sages has shown, with great acuteness, that it was impressed upon mankind only by the inconveniences which injustice had produced. 'In the first ages (says he) men acted without any rule but the impulse of desire; they practised injustice upon others, and suffered it from others in their turn: but in time it was discovered, that the pain of suffering wrong was greater than the pleasure of doing it; and mankind, by a general compact, submitted to the restraint of laws, and resigned the pleasure to escape the pain.'

"Of charity, it is superfluous to observe, that it could have no place if there were no want; for of a virtue which could not be practised, the omission could not be culpable. Evil is not only the occasional but the efficient cause of charity; we are incited to the relief of misery by the consciousness that we have the same nature with the sufferer; that we are in danger of the same distresses, and may some time implore the same assistance.

"Godliness

Providence

"Godlineſs or piety is elevation of the mind towards the Supreme Being, and extenſion of the thoughts of another life. The other life is future, and the Supreme Being is inviſible. None would have recourſe to an inviſible power, but that all other ſubjects had eluded their hopes. None would fix their attention upon the future, but that they are diſcontented with the preſent. If the ſenſes were feaſted with perpetual pleaſure, they would always keep the mind in ſubjection. Reaſon has no authority over us but by its power to warn us againſt evil.

"In childhood, while our minds are yet unoccupied, religion is impreſſed upon them; and the firſt years of almoſt all who have been well educated are paſſed in a regular diſcharge of the duties of piety: But as we advance forward into the crowds of life, innumerable delights ſolicit our inclinations, and innumerable cares diſtract our attention. The time of youth is paſſed in noiſy frolics; manhood is led on from hope to hope, and from project to project; the diſſoluteneſs of pleaſure, the inebriation of ſucceſs, the ardour of expectation, and the vehemence of competition, chain down the mind alike to the preſent ſcene: nor is it remembered how ſoon this miſt of trifles muſt be ſcattered, and the bubbles that float upon the rivulet of life be loſt for ever in the gulph of eternity. To this conſideration ſcarce any man is awakened but by ſome preſſing and reſiſtleſs evil; the death of thoſe from whom he derived his pleaſures, or to whom he deſtined his poſſeſſions, ſome diſeaſe which ſhows him the vanity of all external acquiſitions, or the gloom of age which intercepts his proſpects of long enjoyment, forces him to fix his hopes upon another ſtate; and when he has contended with the tempeſts of life till his ſtrength fails him, he flies at laſt to the ſhelter of religion.

"That miſery does not make all virtuous, experience too certainly informs us; but it is no leſs certain, that of what virtue there is, miſery produces far the greater part. Phyſical evil may be therefore endured with patience, ſince it is the cauſe of moral good; and patience itſelf is one virtue by which we are prepared for that ſtate in which evil ſhall be no more."

25 Objection from the permiſſion of moral guilt,

The calamities and the hardſhips of our preſent ſtate, then, are ſo far from being real evils, of which providence ought to be accuſed, that in every point of view in which we can conſider them, they afford the ſureſt proofs of the wiſdom of its adminiſtration, and of its goodneſs to man.

The moſt ſerious difficulty lies in accounting for the permiſſion of moral evil or guilt, in a ſyſtem governed by infinite benevolence and wiſdom. Thoſe who in a conſiſtent manner hold the doctrine of the abſolute neceſſity of human actions in its full extent, and acknowledge all its conſequences, find it eaſy to elude this difficulty. They very fairly deny the exiſtence of any ſuch thing as moral evil in the abſtract; and aſſert, that what we call a *crime*, is nothing more than an action which we always regard with a painful ſenſation: that theſe apparent evils endure only for a time; and that all will at laſt terminate in the perfection and happineſs of every intelligent being.

26 Anſwered.

Upon the ſyſtem of liberty, the ſhorteſt anſwer ſeems to be this: that ſome things are abſolutely impoſſible, not from any weakneſs in the Deity, but becauſe they infer abſurdity or contradiction. Thus it is impoſſible for twice two to be any thing elſe than four; and thus it is impoſſible for Omnipotence itſelf to confer ſelf-approbation upon an intelligent being who has never deſerved it; that is to ſay, it is impoſſible for a man of ſenſe to be pleaſed with himſelf for having done a certain action, while he himſelf is conſcious that he never did that action. But ſelf-approbation conſtitutes the higheſt, the moſt unmingled, and permanent felicity, of which our nature is capable. It is not in the power of Omnipotence itſelf, then, to beſtow the higheſt and moſt permanent felicity of our nature; it muſt be *earned* and deſerved before it can be obtained. In the ſame manner good deſert, virtue or merit, cannot be *conferred;* they muſt be *acquired.* To enable us to acquire theſe, we muſt be expoſed to difficulties, and muſt ſuffer in a certain degree. If theſe difficulties had no influence upon our conduct and feelings, if they expoſed us to no real danger, no fabric of merit and of ſelf-approbation could be reared upon them. All that the Supreme Being could do for us, was to confer ſuch an original conſtitution and character as would enable us to do well if we ſhould exert our utmoſt powers. The univerſe is not ruled by favour, but by juſtice. Complete felicity muſt be purchaſed. Guilt is an abuſe of our freedom, a doing ill where we could have done well, and is entirely the work of man. Heaven could not avoid permitting its exiſtence, and expoſing us to danger; for temptation is neceſſary to virtue, and virtue is the perfection of our nature, our glory, and our happineſs.

27 By Simplicius.

The permiſſion of moral evil has been ſo ably accounted for by Simplicius, a Pagan writer, and therefore not biaſſed by any partiality to the Jewiſh or Chriſtian Scriptures, that we cannot deny ourſelves the pleaſure of laying his reaſoning before our readers He aſks *, "Whether God may be called the author of ſin, becauſe he permits the ſoul to uſe her liberty? and anſwers the queſtion thus:

* *Simplic. Com. in Epict.* pag. 186, 187. *ed. Salmaſ.*

"He who ſays that God ſhould not permit the exerciſe of its freedom to the ſoul, muſt affirm one of theſe two things; either that the ſoul, though by nature capable of indifferently chooſing *good* or *evil*, ſhould yet be conſtantly prevented from chooſing evil; or elſe that it ſhould have been made of ſuch a nature as to have no *power* of chooſing *evil.*

"The former aſſertion (continues he) is irrational and abſurd; for what kind of liberty would that be in which there ſhould be no freedom of choice? and what choice could there be, if the mind were conſtantly reſtrained to one ſide of every alternative? With reſpect to the ſecond aſſertion, it is to be obſerved (ſays he), that no evil is in itſelf deſirable, or can be choſen *as evil.* But if this power of determining itſelf either way in any given caſe muſt be taken from the ſoul, it muſt either be as ſomething not good, or as ſome great evil. But whoever ſaith ſo, does not conſider how many things there are which, though accounted good and deſirable, are yet never put in competiton with this freedom of will: for without it we ſhould be on a level with the brutes; and there is no perſon who would rather be a brute than a man. If God then ſhows his goodneſs in giving to inferior beings ſuch perfections as are far below this, is it incongruous to the divine nature and goodneſs to give man a ſelf-determining power over his actions, and to permit him the free exerciſe of that power?

Providence power? Had God, to prevent man's sin, taken away the liberty of his will, he would likewise have destroyed the foundation of all virtue, and the very nature of man; for there could be no virtue were there not a possibility of vice; and man's nature, had it continued rational, would have been divine, because impeccable. Therefore (continues he), though we attribute to God, as its author, this self-determining power, which is so necessary in the order of the universe; we have no reason to attribute to him that evil which comes by the abuse of liberty: For God doth not cause that aversion from good which is in the soul when it sins; he only gave to the soul such a power as might turn itself to evil, out of which he produces much good, which, without such a power, could not have been produced by Omnipotence itself." So consonant to the doctrine of our scriptures is the reasoning of this opponent of the writings of Moses! *Fas est et ab hoste doceri.*

28 Objection from the apparent confusion of human affairs, The last objection to the belief of a divine providence arises from the apparent confusion of human affairs, that all things happen alike to all, that bad men are prosperous, and that a total want of justice appears to attend the divine administrations. Even the best men have at times been shaken by this consideration.—But there are many reasons for rendering this world a mixed scene: it would become unfit for a state of trial and of education to virtue were it otherwise.

29 Answered, It has been shown already, that physical evil is the parent of moral good; and therefore it would be absurd to expect that the virtuous should be entirely exempted from that evil. For the occasional prosperity of the wicked, many reasons have been assigned even by those who, in their disquisitions, were not guided by that revelation which has brought to light life and immortality.

30 By Plutarch. "God (says Plutarch) spares the wicked, that he may set to mankind an example of forbearance, and teach them not to revenge their injuries too hastily on each other. He spares some wicked men from early punishment, in order to make them instruments of his justice in punishing others. And he spares all for a time, that they may have leisure for repentance; for men (says the same excellent moralist) look at nothing further, in the punishments which they inflict, than to satisfy their revenge and malice, and therefore they pursue those who have offended them with the utmost rage and eagerness; whereas God, aiming at the cure of those who are not utterly incurable, gives them μεταβαλλεσθαι χρονον, "time to be converted."

31 The immortality of the soul the best answer to this objection. But this objection receives the best solution from the doctrine of the immortality of the human soul.

——————And see!
'Tis come, the glorious morn! the second birth
Of heav'n and earth! awakening nature hears
The *new creating word*, and starts to life,
In every height'ned form, from pain and death
For ever free. *The great eternal scheme*,
Involving all, and in a *perfect whole*
Uniting, as the prospect wider spreads,
To reason's eye cleared up a-pace.
Ye vainly wise! Ye blind presumptuous! now,
Confounded in the dust, adore that Pow'r
And Wisdom oft arraign'd: see now the cause,
Why unassuming worth in secret liv'd
And died neglected: why the good man's share
In life was gall and bitterness of soul:
Why the lone widow and her orphans pin'd
In starving solitude; while luxury,
In palaces, lay straining her low thought,
To form unreal wants: why heav'n-born truth,
And moderation fair, wore the red marks
Of superstition's scourge: why licens'd pain,
That cruel spoiler, that embosom'd foe,
Imbitter'd all our bliss. Ye good distrest!
Ye noble few! who here unbending stand
Beneath life's pressure, yet bear up a while,
And what your bounded view, which only saw
A little part, deem'd evil, is no more:
The storms of wintry time will quickly pass,
And one unbounded spring encircle all.

Thomson's Winter.

Providence-Plantation, a colony of New-England, which, with Rhode-island, formerly constituted a charter government. Its chief town is Newport.

Providence, one of the least of the Bahama islands in the American ocean, but the best of those planted and fortified by the English. It is seated on the east side of the gulph of Florida. W. Long. 77. 35. N. Lat. 25. 0.

PROVINCE, in Roman antiquity, a country of considerable extent, which, upon being entirely reduced under the Roman dominion, was new-modelled according to the pleasure of the conquerors, and subjected to the command of annual governors, sent from Rome; being commonly obliged to pay such taxes and contributions as the senate thought fit to demand.

Of these countries, that part of France next the Alps was one, and still retains the name *Provence*.

Nicod derives the word *a procul vivendo*, "living afar off;" but it is better deduced from *pro* and *vinco* "I overcome."

Province, in geography, a division of a kingdom or state, comprising several cities, towns, &c. all under the same government, and usually distinguished by the extent either of the civil or ecclesiastical jurisdiction.

The church distinguishes its provinces by archbishoprics; in which sense, England is divided into two provinces, Canterbury and York.

The United Provinces are seven provinces of the Netherlands, who, revolting from the Spanish dominion, made a perpetual alliance, offensive and defensive, at Utrecht, anno 1579. See *United Provinces.*

PROVINCIAL, something relating to a province. It also denotes, in Romish countries, a person who has the direction of the several convents of a province.

PROVISIONS, in a military sense, implies all manner of eatables, food or provender, used in an army, both for man and beast.

PROVOST of a city or town, is the chief municipal magistrate in several trading cities, particularly Edinburgh, Paris, &c. being much the same with mayor in other places. He presides in city-courts, and, together with the bailies, who are his deputies, determines in all differences that arise among citizens.

The provost of Edinburgh is called *lord*, and the same title is claimed by the provost of Glasgow. The former calls yearly conventions of the royal boroughs to Edinburgh by his missives, and is, *ex officio*, president to the convention when met.

Provost, *or Prevot-Royal*, a sort of inferior judge formerly established throughout France, to take cognizance of all civil, personal, real, and mixed causes, among the people only.

Grand Provost of France, or *of the Household*, had jurisdiction in the king's house, and over the officers therein; looked to the policy thereof, the regulation of provisions, &c.

Grand Provost of the Constable, a judge who manages processes against the soldiers in the army who have committed any crime.

He has four lieutenants distributed throughout the army, called *provosts of the army*, and particularly provosts in the several regiments.

Provost Marshal of an Army, is an officer appointed to seize and secure deserters, and all other criminals. He is to hinder soldiers from pillaging, to indict offenders, and see the sentence passed on them executed. He also regulates the weights and measures, and the price of provisions, &c. in the army. For the discharge of his office, he has a lieutenant, a clerk, and a troop of marshal-men on horseback, as also an executioner.

There is also a provost-marshal in the navy, who hath charge over prisoners, &c.

The French also had a provost-general of the marines, whose duty it was to prosecute the marines when guilty of any crime, and to make report thereof to the council of war; besides a marine provost in every vessel, who was a kind of gaoler, and took the prisoners into his care, and kept the vessel clean.

Provosts of the Marshals, were a kind of lieutenants of the marshals of France; of these there were 180 seats in France; their chief jurisdiction regarded highwaymen, footpads, house-breakers, &c.

Provost of the Mint, a particular judge instituted for the apprehending and prosecuting of false coiners.

Provost, or *Prevot*, in the king's stables; his office is to attend at court, and hold the king's stirrup when he mounts his horse. There are four provosts of this kind, each of whom attends in his turn, monthly.

PROW, denotes the head or fore-part of a ship, particularly in a galley; being that which is opposite to the poop or stern.

PROXIMITY, denotes the relation of nearness, either in respect of place, blood, or alliance.

PRUDENCE, in ethics, may be defined an ability of judging what is best, in the choice both of ends and means. According to the definition of the Roman moralist, *De Officiis*, lib. i. cap. 43. prudence is the knowledge of what is to be desired or avoided. Accordingly, he makes *prudentia (De Legibus*, lib. i.) to be a contraction of *providentia*, or foresight. Plato (*De Legibus*, lib. iii.) calls this the leading virtue; and Juvenal, Sat. x. observes,

Nullum numen abest si sit prudentia.

The idea of prudence includes ευβουλια, or due consultation; that is, concerning such things as demand consultation in a right manner, and for a competent time, that the resolution taken up may be neither too precipitate nor too slow; and συνεσις, or a faculty of discerning proper means when they occur; and to the perfection of prudence, these three things are farther required, viz. δεινοτης, or a natural sagacity; αγχινοια, presence of mind, or a ready turn of thought; and εμπειρια, or experience. The extremes of prudence are craft or cunning on the one hand, which is the pursuit of an ill end by direct and proper though not honest means; and folly on the other, which is either a mistake, both as to the end and means, or prosecuting a good end by foreign and improper means. Grove's *Moral Philosophy*, vol. ii. chap. ii..

PRUDENTIUS, or Aurelius Prudentius Clemens, a famous Christian poet, under the reign of Theodosius the Great, who was born in Spain in the year 348. He first followed the profession of an advocate, was afterwards a judge, then a soldier, and at length had an honourable employment at court. We have a great number of his poems, which, from the choice of his subjects, may be termed *Christian poems*; but the style is barbarous, and very different from the purity of the Augustan age. The most esteemed editions of Prudentius's works are that of Amsterdam, in 1667, with Heinsius's Notes, and that of Paris in 1687, *in usum Delphini*.

PRUNELLA, in botany: A genus of the gymnospermia order, belonging to the didynamia class of plants; and in the natural method ranking under the 12th order, *holoraceæ*. The filaments are bifurcated, with an anthera only on one point; the stigma is bifid.

PRUNES, are plums dried in the sunshine, or in an oven.

PRUNING, in gardening and agriculture, is the lopping off the superfluous branches of trees, in order to make them bear better fruit, grow higher, or appear more regular.

Pruning, though an operation of very general use, is nevertheless rightly understood by few; nor is it to be learned by rote, but requires a strict observation of the different manners of growth of the several sorts of fruit-trees; the proper method of doing which cannot be known without carefully observing how each kind is naturally disposed to produce its fruit: for some do this on the same year's wood, as vines; others, for the most part, upon the former year's wood, as peaches, nectarines, &c.; and others upon spurs which are produced upon wood of three, four, &c. to fifteen or twenty years old, as pears, plums, cherries, &c. Therefore, in order to the right management of fruit-trees, provision should always be made to have a sufficient quantity of bearing wood in every part of the trees; and at the same time there should not be a superfluity of useless branches, which would exhaust the strength of the trees, and cause them to decay in a few years.

The reasons for pruning of fruit-trees, are, 1. To preserve them longer in a vigorous bearing-state; 2. To render them more beautiful; and, 3. To cause the fruit to be larger and better tasted.

The general instructions for pruning are as follow. The greatest care ought to be taken of fruit-trees in the spring, when they are in vigorous growth; which is the only proper season for procuring a quantity of good wood in the different parts of the tree, and for displacing all useless branches as soon as they are produced, in order that the vigour of the tree may be entirely distributed to such branches only as are designed to remain. For this reason trees ought not to be neglected in April and May, when their shoots are produced: however, those branches which are intended for bearing

the

the fucceeding year fhould not be fhortened during the time of their growth, becaufe this would caufe them to produce two lateral fhoots, from the eyes below the place where they were ftopped, which would draw much of the ftrength from the buds of the firft fhoot: and if the two lateral fhoots are not entirely cut away at the winter-pruning, they will prove injurious to the tree. This is to be chiefly underftood of ftone-fruit and grapes; but pears and apples, being much harder, fuffer not fo much, though it is a great difadvantage to thofe alfo to be thus managed. It muft likewife be remarked, that peaches, nectarines, apricots, cherries, and plums, are always in the greateft vigour when they are leaft maimed by the knife; for where large branches are taken off, they are fubject to gum and decay. It is therefore the moft prudent method to rub off all ufelefs buds when they are firft produced, and to pinch others, where new fhoots are wanted to fupply the vacancies of the wall; by which management they may be fo ordered as to want but little of the knife in winter-pruning. The management of pears and apples is much the fame with thefe trees in fummer; but in winter they muft be very differently pruned: for as peaches and nectarines, for the moft part, produce their fruit upon the former year's wood, and muft therefore have their branches fhortened according to their ftrength, in order to produce new fhoots for the fucceeding year; fo, on the contrary, pears, apples, plums, and cherries, producing their fruit upon fpurs, which come out of the wood of five, fix, and feven years old, fhould not be fhortened, becaufe thereby thofe buds which were naturally difpofed to form thefe fpurs, would produce wood-branches; by which means the trees would be filled with wood, but would never produce much fruit. The branches of ftandard-trees fhould never be fhortened unlefs where they are very luxuriant, and, by growing irregularly on one fide of the trees, attract the greateft part of the fap, by which means the other parts are either unfurnifhed with branches, or are rendered very weak; in which cafe the branch fhould be fhortened down as low as is neceffary, in order to obtain more branches to fill up the hollow of the tree: but this is only to be underftood of pears and apples, which will produce fhoots from wood of three, four, or more years old; whereas moft forts of ftone-fruit will gum and decay after fuch amputations: whenever this happens to ftone-fruit, it fhould be remedied by ftopping or pinching thofe fhoots in the fpring, before they have obtained too much vigour, which will caufe them to pufh out fide-branches; but this muft be done with caution. You muft alfo cut out all dead or decaying branches, which caufe their heads to look ragged, and alfo attract noxious particles from the air: in doing of this, you fhould cut them clofe down to the place where they were produced, otherwife that part of the branch which is left will alfo decay, and prove equally hurtful to the reft of the tree; for it feldom happens, when a branch begins to decay, that it does not die quite down to the place where it was produced, and if permitted to remain long uncut, often infects fome of the other parts of the tree. If the branches cut off are large, it will be very proper, after having fmoothed the cut part exactly even with a knife, chiffel, or hatchet, to put on a plafter of grafting clay, which will prevent the wet from foaking into the tree at the wounded part. All fuch branches as run acrofs each other, and occafion a confufion in the head of the tree, fhould be cut off; and as there are frequently young vigorous fhoots on old trees, which rife from the old branches near the trunk, and grow upright into the head, thefe fhould be carefully cut out every year, left, by being permitted to grow, they fill the tree too full of wood.

As to the pruning of foreft-trees, if they be large, it is beft not to prune them at all; yet, if there be an abfolute neceffity, avoid taking off large boughs as much as poffible. And, 1. If the bough be fmall, cut it fmooth, clofe, and floping. 2. If the branch be large, and the tree old, cut it off at three or four feet from the ftem. 3. If the tree grow crooked, cut it off at the crook, floping upward, and nurfe up one of the moft promifing fhoots for a new ftem. 4. If the tree grow top-heavy, its head muft be lightened, and that by thinning the boughs that grow out of the main branches. But if you would have them fpring, rub off the buds, and fhroud up the fide-fhoots. 5. If the fide-bough ftill break out, and the top be able to fuftain itfelf, give the boughs that put forth in fpring a pruning after Midfummer, cutting them clofe.

PRUNUS, in botany: A genus of the monogynia order, belonging to the icofandria clafs of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid, inferior; there are five petals; the fruit is a plum, having a kernel with prominent futures. There are 15 fpecies, of which fix are cultivated in Britain: they are originally natives of America and Siberia.

1. The domeftica, or common plum-tree, grows 20 or 30 feet high, garnifhed with oval, fpear-fhaped leaves, and with the pedunculi for the moft part fingle, terminated by flowers, fucceeded by plums of many different colours, fizes, and fhapes in the varieties. 2. The infititia, wild-plum, or bullace-tree, grows 12 or 15 feet high; the branches fomewhat fpinous; the leaves oval, hairy underneath; and the pedunculi by pairs, terminated by white flowers fucceeded by fmall, round, plum-like, fruit of different colours in the varieties. 3. The fpinofa, black-thorn, or floe-tree, grows 10 or 12 feet high, very branchy and bufhy quite from bottom, armed with ftrong, fharp fpines, fmall, fpear-fhaped, fmooth leaves, pedunculi growing fingly, terminated by flowers, fucceeded by fmall, round, black cherries in autumn. It grows wild everywhere in hedges and woods; and is very proper for planting field hedges, being of very quick and clofe growth. 4. The cerafus, or common cherry-tree, grows 20 feet or more in height, garnifhed with oval clufters of lanceolate, fmooth leaves, umbellate flowers, fucceeded by clufters of red roundifh fruit of different fizes and properties in the varieties. Hanbury fays, "were this tree fcarce, and with much difficulty propagated, every man, though poffeffed of a fingle tree only, would look upon it as a treafure; for befides the charming appearance thefe trees have, when befnowed, as it were, all over with bloom in the fpring, can any tree in the vegetable tribe be conceived more beautiful, ftriking, and grand, than a well-grown and healthy cherry-tree, at that period when the fruit is ripe."

The many kinds of cherry-trees afford an almoft endlefs variety; all differing in fome refpect in their manner of fhooting, leaves, flowers, or fruit: two in particular demand admiffion into the pleafure-garden; the double-bloffomed and the red-flowering. The pleafing fhow the common cherry-tree makes when in blow is known

Pruning. known to all; but that of the double-bloffomed is much more enchanting. It bloffoms like the other in May; the flowers are produced in large and noble clufters; for each feparate flower is as double as a rofe, is very large, and placed on long and flender footftalks, fo as to occafion the branches to have an air of eafe and freedom. They are of a pure white; and the trees will be fo profufely covered with them, as to charm the imagination. Standards of thefe trees, when viewed at a diftance, have been compared to balls of fnow; and the nearer we approach, the greater pleafure we receive. Thefe trees may be kept as dwarfs, or trained up to ftandards; fo that there is no garden or plantation to which they will not be fuitable. By the multiplicity of the petals the organs of generation are deftroyed; fo that thofe flowers which are really full are never fucceeded by any fruit.

The red-flowering cherry-tree differs in no refpect from the common cherry-tree, only that the flowers are of a pale-red colour, and by many are efteemed on that account. Befides the ornament and utility afforded us by the flowers and fruit of the cherry, its timber is a further inducement for propagating it; more efpecially that of the fmall black wilding fort; which may perhaps with propriety be confidered as the genuine fpecies, and a native of this ifland. Be this as it may, it will grow, in a foil and fituation it affects, to be a large timber tree; which, if taken in its prime before it become tainted at the heart, will turn out perhaps not lefs than a ton of valuable materials, peculiarly adapted to the purpofes of furniture. The grain is fine, and the colour nearly approaching to that of mahogany, to which valuable wood it comes nearer than any other which this country produces. 5. The avium, or great wild-cherry tree, grows 40 or 50 feet high, having oval, fpear-fhaped leaves, downy underneath, with umbellate feffile clufters of white flowers, fucceeded by fmall round fruit of different properties in the varieties. 6. The padus, or common bird-cherry tree, grows 15 or 20 feet high, of a fhrub-like growth, with a fpreading head, large, oblong, rough, ferrated leaves, having two glands at the back of the bafe like the other, and with fhorter, more compact clufters of flowers, fucceeded by large red fruit. This grows wild in hedges in the north parts of England. 7. The Virginiana, or Virginian bird-cherry, grows 30 feet high, dividing into a very branchy head, having a dark purple bark, oval, flightly ferrated, fhining green leaves, having two glands at the forepart of the bafe, and long clufters of white flowers, fucceeded by fmall, round, berry-like, black fruit. 8. The Canadenfis, or Canada dwarf bird cherry, grows but four or five feet high, branching horizontally near the ground with fmooth branches; broad, fpear-fhaped, rough downy leaves without glands; and long clufters of white flowers, fucceeded by fmall, round, berry-like, black fruit, ripe in autumn. 9. The mahaleb, or perfumed cherry, grows 10 or 15 feet high, with fmooth whitifh branches, fmall, oval, fhining green leaves, and corymbous clufters of white flowers, fucceeded by fmall fruit. 10. The armeniaca, or apricot tree, grows 20 feet high, with a large fpreading head, having reddifh fhoots, large nearly heart-fhaped leaves, and clofe-fitting pale-red flowers rifing all along the fides of the young branches; fucceeded by large, roundifh fruit of a yellow and reddifh colour in different varieties. The fruit and the kernels of the *Prunus Siberica*, when eaten, excite a continued head-ach: the kernels, infufed in brandy, communicate an agreeable flavour.

Culture. All the different varieties of plums have at firft been raifed from the ftones, and are afterwards preferved by budding and grafting on any plum-ftock. The fame method is applicable to cherries; only thefe are grafted to moft advantage upon ftocks of the wild black and red cherry raifed from the ftones of the fruit. The apricot-trees are propagated by budding on any kind of plum-ftocks.

Prufa || Pruffia.

PRUSA (anc. geog.), a town fituated at mount Olympus in Myfia, built by Prufias, who waged war with Croefus, (Strabo); with Cyrus, (Stephanus); both cotemporary princes. Now called *Burfa* or *Prufa*, capital of Bithynia, in Afia Minor. E. Long. 29. 5. N. Lat. 39. 22.

PRUSIAS, the name of feveral kings of Bithynia.

Prusias, a town of Bithynia, anciently called *Cios*, from a cognominal river, and giving name to the Sinus Cianus of the Propontis; rebuilt by Prufias the fon of Zela, after having been deftroyed by Philip the fon of Demetrius: it ftood on the Sinus Cianus, at the foot of mount Arganthonius. This is the Prufias who harboured Annibal after the defeat of Antiochus.—Of this place was Afclepiades, furnamed *Prufieus*, the famous phyfician.

Plate CCCCX.

PRUSSIA, a modern, but defervedly celebrated kingdom of Europe, whofe monarch, along with Pruffia Proper, poffeffes alfo the electorate of Brandenburg, and fome other territories of confiderable extent. The diftrict properly called *Pruffia* is of great extent, and divided into the Ducal and Regal Pruffia, the latter belonging to the republic of Poland till the late partition of the Polifh territories. Both together are of great extent; being bounded on the north by the Baltic, on the fouth by Poland and the duchy of Mazovia, on the weft by Pomerania, and on the eaft by Lithuania and Samogitia. The name is by fome thought to be derived from the *Boruffi*, a tribe of the Sarmatians, who, migrating from the foot of the Riphæan mountains, were tempted by the beauty and fertility of the country to fettle there. Others think that the name of this country is properly *Poruffia; Po* in the language of the natives fignifying *near*, and *Poruffia* fignifying *near Ruffia*. To the latter etymology we find the king of Pruffia himfelf affenting in the treatife intitled *Memoirs of the Houfe of Brandenburg*. However, it muft be owned, that thefe or any other etymologies of the word are very uncertain, and we find nothing like it mentioned by hiftorians before the tenth century.

1 Etymology of the name.

2 Extreme barbarity of the ancient inhabitants.

The ancient ftate of Pruffia is almoft entirely unknown. However, the people are faid to have been very favage and barbarous; living upon raw flefh, and drinking the blood of horfes at their feafts, according to Stella, even to intoxication (A). Nay, fo extremely

(A) This author does not mention any particular method by which they communicated an inebriating quality to the blood of animals. Poffibly, however, the vital fluid may have a property of this kind, though unknown in our days where fuch barbarous cuftoms are difufed. Drunkennefs from drinking blood is frequently mentioned in Scripture, but whether literally or metaphorically muft be decided by the learned.

Prussia.

ly savage were this people, that they were even unacquainted with the method of constructing huts, and took up their dwelling in caves and cavities of rocks and trees, where they protected themselves and children from the inclemencies of the weather. Among such a people it is vain to expect that any transactions would be recorded, or indeed that any thing worthy of being recorded would be transacted. We shall therefore begin our history of Prussia with the time when the Teutonic knights first got footing in the country. (See TEUTONIC *Knights*).

3 Teutonic knights first get footing in the country.

On the expulsion of the Christians from the Holy Land by Saladin, a settlement was given to the Teutonic knights in Prussia by Conrade duke of Mazovia, the competitor of Boleslaus V. for the crown of Poland. Their first residence in this country was Culm; to which territory they were confined by the conditions of the donation, excepting what they could conquer from their pagan neighbours, all which the emperor granted to them in perpetuity.

Encouraged by this grant, the knights conquered the greatest part of the country which now goes by the name of *Prussia*; and, not content with this, became very troublesome to Poland, insomuch that the monarchs of that kingdom were sometimes obliged to carry on dangerous and bloody wars with them; for an account of which we refer to the article POLAND, n° 61. 67, &c.

The Teutonic order continued in Prussia till the year 1531. Their last grand-master was Albert marquis of Brandenburg, and nephew to Sigismund I. king of Poland. He was preferred to this dignity in hopes that his affinity to Sigismund might procure a restitution of some of the places which had been taken from the order during the former unsuccessful wars with Poland; but in this the fraternity were disappointed. Albert, however, was so far from endeavouring to obtain any favour from his uncle by fair means, that he refused to do homage to him, and immediately began to make preparations for throwing off his dependence altogether, and recovering the whole of Prussia and Pomerania by force of arms. In this he was so far from succeeding, that, being foiled in every attempt, he was forced to resign the dignity of grand-master; in recompense for which, his uncle bestowed on him that part of Prussia now called *Ducal*, in quality of a secular duke. It was now the interest of the house of Brandenburg to assist in the expulsion of the fraternity; and accordingly, being at last driven out of Prussia and Pomerania, they transferred their chapter to Mariendal in Franconia; but in that and other provinces of the empire where they settled, little more than the name of the order once so famous now remains.

4 Expelled.

5 History of Brandenburg.

The other most considerable part of his Prussian majesty's dominions is the Electorate of Brandenburg. Like other parts of Germany, it was anciently possessed by barbarians, of whom no history can be given. These were subdued by Charlemagne, as is related under the article FRANCE *; but being on every occasion ready to revolt, in 927 Henry the Fowler established margraves, or governors of the frontiers, to keep the barbarians in awe. The first margrave of Brandenburg was Sigefroy, brother-in-law to the above-mentioned emperor; under whose administration the bishoprics of Brandenburg and Havelberg were established by Otho I. From this Sigefroy, to the succession of the house of Hohenzollern, from whom the present elector is descended, there are reckoned eight different families, who have been margraves of Brandenburg; namely, the family of the Saxons, of Walbeck, Staden, Plenck, Anhalt, Bavaria, Luxemburg, and Misnia. The margraves of the four first races had continual wars with the Vandals and other barbarous people; nor could their ravages be stopped till the reign of Albert surnamed *the Bear*, the first prince of the house of Anhalt. He was made margrave by the emperor Conrad III. and afterwards raised to the dignity of elector by Frederic Barbarossa, about the year 1100. Some years afterwards the king of the Vandals dying without issue, left the Middle Marche by his last will to the elector, who was besides possessed of the old March, Upper Saxony, the country of Anhalt, and part of Luface. In 1332 this line became extinct, and the electorate devolved to the empire. It was then given by the emperor Louis of Bavaria to his son Louis, who was the first of the sixth race. Louis the Roman succeeded his brother; and as he also died without children, he was succeeded by Otho, his third brother, who sold the electorate to the emperor Charles IV. of the house of Luxemburg, for 200,000 florins of gold. Charles IV. gave the Marche to his son Winceslaus, to whom Sigismund succeeded. This elector, being embarrassed in his circumstances, sold the New Marche to the knights of the Teutonic order. Josse succeeded Sigismund; but aspiring to the empire, sold the electorate to William duke of Misnia; who, after he had possessed it for one year, sold it again to the emperor Sigismund. In 1417, Frederic VI. burgrave of Nuremberg, received the investiture of the country of Brandenburg at the diet of Constance from the hands of the emperor Sigismund; who, two years before, had conferred upon him the dignity of elector, and arch-chamberlain of the Holy Roman empire.

* N° 27, &c.

This prince, the first of the family of Hohenzollern, found himself possessed of the Old and Middle Marche, but the dukes of Pomerania had usurped the Marche Ukraine. Against them, therefore, the elector immediately declared war, and soon recovered the province. As the New Marche still continued in the hands of the Teutonic knights, to whom it had been sold as we have already mentioned, the elector, to make up for this, took possession of Saxony, which at that time happened to be vacant by the death of Albert the last elector of the Anhalt line. But the emperor, not approving of this step, gave the investiture of Saxony to the duke of Misnia; upon which Frederic voluntarily desisted from his acquisitions. This elector made a division of his possessions by will. His eldest son was deprived of his right on account of his having too closely applied himself to search for the philosopher's stone; so he left him only Voigtland. The electorate was given to his second son Frederic; Albert, surnamed *Achilles*, had the duchies of Franconia; and Frederic, surnamed the *Fat*, had the Old Marche; but by his death it returned to the electorate of Brandenburg.

Frederic I. was succeeded by his son, called also *Frederic*, and surnamed *Iron-tooth* on account of his strength. He might with as great reason have been surnamed *the Magnanimous*, since he refused two crowns, viz. that of Bohemia, which was offered him

 by

Pruſſia.

by the pope, and the kingdom of Poland to which he was invited by the people; but Frederic declared he would not accept of it unleſs Caſimir brother to Ladiſlaus the late king refuſed it. Theſe inſtances of magnanimity had ſuch an effect on the neighbouring people, that the ſtates of Lower Luſatia made a voluntary ſurrender of their country to him. But as Luſatia was a fief of Bohemia, the king of that country immediately made war on the elector, in order to recover it. However, he was ſo far from being ſucceſsful, that, by a treaty of peace concluded in 1462, he was obliged to yield the perpetual ſovereignty of Corbus, Peits, Sommerfeld, and ſome other places, to the elector. Frederic then, having redeemed the New Marche from the Teutonic order for the ſum of 100,000 florins, and ſtill further enlarged his dominions, reſigned the ſovereignty in 1469 to his brother Albert, ſurnamed *Achilles*.

6 Exploits of Albert ſurnamed *Achilles*.

Albert was 57 years old when his brother reſigned the electorate to him. Moſt of his exploits, for which he had the ſurname of *Achilles*, had been performed while he was burgrave of Nuremberg. He declared war againſt Lewis duke of Bavaria, defeated, and took him priſoner. He gained eight battles againſt the Nurembergers, who had rebelled and conteſted his rights to the burgraviate. In one of theſe he fought ſingly againſt 16 men, till his people came up to his aſſiſtance. He made himſelf maſter of the town of Greiffenburg in the ſame manner that Alexander the Great took the capital of the Oxydracæ, by leaping from the top of the walls into the town, where he defended himſelf ſingly againſt the inhabitants till his men forced the gates and reſcued him. The confidence which the emperor Frederic III. placed in him, gained him the direction of almoſt the whole empire. He commanded the Imperial armies againſt Lewis the Rich duke of Bavaria; and againſt Charles the Bold duke of Burgundy, who had laid ſiege to Nuis, but concluded a peace at the interpoſition of Albert. He gained the prize at 17 tournaments, and was never diſmounted.

7 Pruſſia and Brandenburg united.

All theſe exploits, however, had been performed before Albert obtained the electorate. From that time we meet with no very important tranſactions till the year 1594, when John Sigiſmund of Brandenburg, having married Anne the only daughter of Albert duke of Pruſſia, this united that duchy to the electorate, to which it has continued to be united ever ſince; and obtained pretenſions to the countries of Juliers, Berg, Cleves, Marck, Ravenſburg, and Ravenſtein, to the ſucceſſion of which Anne was heireſs.

8 Uufortunate reign of the elector George William.

Sigiſmund died in 1619, and was ſucceeded by his ſon George William; during whoſe government the electorate ſuffered the moſt miſerable calamities. At this time it was that the war commenced between the Proteſtants and Catholics, which laſted 30 years. The former, although leagued together, were on the point of being utterly deſtroyed by the Imperialiſts under the command of Count Tilly and Wallenſtein, when Guſtavus Adolphus of Sweden turned the ſcale in their favour, and threatened the Catholic party with utter deſtruction *. But by his death at the battle of Lutzen, the fortune of war was once more changed. At laſt, however, peace was concluded with the emperor; and, in 1640, the elector died, leaving his dominions to his ſon Frederic William, ſurnamed the *Great*.

* See *Sweden*.

9 Reign of Frederic William the Great.

This young prince, though only 20 years of age at the time of his acceſſion, applied himſelf with the utmoſt diligence to repair the loſſes and devaſtations occaſioned by the dreadful wars which had preceded. He received the inveſtiture of Pruſſia perſonally from the king of Poland, on condition of paying 100,000 florins annually, and not making truce or peace with the enemies of that crown. His envoy likewiſe received the inveſtiture of the electorate from the emperor Ferdinand III. The elector then thought of recovering his provinces from thoſe who had uſurped them. He concluded a truce for 20 years with the Swedes, who evacuated the greateſt part of his eſtates. He likewiſe paid 140,000 crowns to the Swediſh garriſons, which ſtill poſſeſſed ſome of his towns; and he concluded a treaty with the Heſſians, who delivered up a part of the duchy of Cleves; and obtained of the Hollanders the evacuation of ſome other cities.

In the mean time, the powers of Europe began to be weary of a war which had continued for ſuch a length of time with ſuch unrelenting fury. The cities of Oſnaburg and Munſter being choſen as the moſt proper places for negociation, the conferences were opened in the year 1645; but, by reaſon of the multiplicity of buſineſs, they were not concluded till two years after. France, which had eſpouſed the intereſts of Sweden, demanded that Pomerania ſhould be ceded to that kingdom as an indemnification for the expences which the war had coſt Guſtavus Adolphus and his ſucceſſors. Although the empire and the elector refuſed to give up Pomerania, it was at laſt agreed to give up to the Swedes Hither Pomerania, with the iſles of Rugen and Wollin, alſo ſome cities; in return for which ceſſion, the biſhoprics of Halberſtadt, Minden, and Camin, were ſecularized in favour of the elector, of which he was put in poſſeſſion, together with the lordſhips of Hochenſtein and Richenſtein, with the reverſion of the archbiſhopric of Magdeburg. This was the treaty of Weſtphalia concluded in 1648, and which ſerves as a baſis to all the poſſeſſions and rights of the German princes. The elector then concluded a new treaty with the Swedes, for the regulation of limits, and for the acquittal of ſome debts, of which Sweden would only pay a fourth; and next year the electorate, Pomerania, and the duchies of Cleves, were evacuated by the Swedes.

10 Treaty of Weſtphalia concluded.

11 The elector ſucceeds againſt the Swedes.

Notwithſtanding all theſe treaties, however, the Swedes ſoon after invaded Pomerania, but were entirely defeated by the elector near the town of Fehrbellin. Three thouſand were left dead on the ſpot, among whom were a great number of officers; and a great many were taken priſoners. The elector then purſued his victory, gained many advantages over the Swedes, and deprived them of the cities of Stralſund and Gripſwald. On this the Swedes, hoping to oblige the elector to evacuate Pomerania, which he had almoſt totally ſubdued, invaded Pruſſia, from Livonia, with 16,000 men; and advancing into the country, they burned the ſuburbs of Memel, and took the cities of Tilſe and Inſterburg. The elector, to oppoſe the invaders, left Berlin on the 10th of January 1679, at the head of 9000 men. The Swedes retired at his approach, and were greatly haraſſed by the

Prussia.

the troops on their march. So ſucceſsful indeed was the elector on this occaſion, that the Swedes loſt almoſt one half of their army killed or taken priſoners. At laſt, having croſſed the bay of Friſch-haff and Courland on the ice, he arrived on the 19th of January, with his infantry, within three miles of Tilſe, where the Swedes had their head-quarters. The ſame day, his general, Treſenfeldt, defeated two regiments of the enemy near Splitter; and the Swedes who were in Tilſe abandoned that place, and retired towards Courland. They were purſued by General Gortz, and entirely defeated with ſuch ſlaughter, that ſcarce 3000 of them returned to Livonia. Yet, notwithſtanding all theſe victories, the elector, being preſſed on the other ſide by the victorious generals of France, M. Turenne and the prince of Conde, was obliged to make peace with the Swedes. The conditions were, that the treaty of Weſtphalia ſhould ſerve for a baſis to the peace; that the elector ſhould have the property of the cuſtoms in all the ports of Further Pomerania, with the cities of Camin, Gartz, Grieffenburg, and Wildenbruck: on his part, he conſented to give up to the Swedes all that he had conquered from them, and to give no aſſiſtance to the king of Denmark, upon condition that France delivered up to him his provinces in Weſtphalia, and paid him 300,000 ducats, as an indemnification for the damages done by the French to his ſtates. This treaty was ſtyled *the peace of St Germain.*

13 With the treaty of St Germain terminated the military exploits of Frederic William, who paſſed the laſt years of his adminiſtration in peace. His great qualities had rendered him reſpected by all Europe, and had even been heard of in Tartary. He received an embaſſy from Murad Geray, cham of the Tartars, courting his friendſhip. The barbarian ambaſſador appeared in ſuch tattered clothes as ſcarce covered his nakedneſs, ſo that they were obliged to furniſh him with other clothes before he could appear at court. His interpreter had a wooden noſe and no ears. In 1684, Frederic received into his dominions great numbers of Proteſtants who fled out of France from the perſecutions of Louis XIV. after he had revoked the edict of Nantz. Twenty thouſand of them are ſaid to have ſettled at this time in the electorate, where they introduced new arts and manufactures, that were of the utmoſt benefit to the country. By this, however, he diſobliged Louis XIV. for which reaſon he concluded an alliance with the emperor; and having furniſhed him with 8000 troops againſt the Turks in Hungary, the emperor yielded to him the circle of Schwibus in Sileſia, as an equivalent for all his rights in that province.

14 In 1688, the elector Frederic William died, and was ſucceeded by his ſon Frederic III. This prince was remarkably fond of ſhow and ceremony, which, during the courſe of his government, involved him in much expence. The regal dignity ſeemed to be the greateſt object of his ambition. To obtain this, he joined with the emperor in the alliance againſt France, in which he was engaged by William III. king of Britain. He alſo yielded up the circle of Schwibus, which had been given to his predeceſſor; and, in 1700, obtained from the emperor that dignity which he had ſo earneſtly deſired. The terms on which it was obtained were, 1. That Frederic ſhould never ſeparate from the empire thoſe provinces of his dominions which depended on it. 2. That he ſhould not, in the emperor's preſence, demand any other marks of honour than thoſe which he had hitherto enjoyed. 3. That his Imperial majeſty, when he wrote to him, ſhould only give him the title of *Royal Dilection.* 4. That nevertheleſs the miniſters which he had at Vienna ſhould be treated like thoſe of other crowned heads. 5. That the elector ſhould maintain 6000 men in Italy at his own expence, in caſe the emperor ſhould be obliged to make war on account of the ſucceſſion of the houſe of Bourbon to the crown of Spain. 6. That thoſe troops ſhould continue there as long as the war laſted.

Thus was the kingdom of Pruſſia eſtabliſhed through the friendſhip of the emperor, with whom Frederic I. ſo called as being the firſt king of Pruſſia, continued all his life in ſtrict alliance. Indeed he was a pacific prince; and though contemptible in his perſon, and incapable of atchieving great things, had this merit, that he always preſerved his dominions in peace, and thus conſulted the true intereſt of his ſubjects much more than thoſe monarchs who have dazzled the eyes of the world by their military exploits. He was indeed vain, and fond of ſhow, as we have already obſerved; but had a good heart, and is ſaid never to have violated his conjugal vow; though it does not appear that he was greatly beloved by his royal conſorts (of whom he had three) on that or any other account. 15

Frederic II. of Pruſſia a martial prince.

Frederic I. died in the beginning of 1713, and was ſucceeded by Frederic William. He was in almoſt every thing the reverſe of his father. His diſpoſitions were altogether martial; ſo that he applied himſelf entirely to the augmentation of his army, and perfecting them in their exerciſe, by which means they became the moſt expert ſoldiers in Europe. His foible was an ambition of having his army compoſed of men above the ordinary ſize; but as theſe could not be procured, he compoſed a regiment of the talleſt men he could find; and as his officers made no ſcruple of picking up ſuch men wherever they could find them for his majeſty's uſe, the neighbouring ſtates were frequently offended, and a war was often likely to enſue even from this ridiculous cauſe. However, his Pruſſian majeſty was never engaged in any martial enterpriſe of conſequence: but having put his army on the moſt reſpectable footing of any in the world, and filled his coffers, for he was of a very ſaving diſpoſition, he put it in the power of his ſon to perform thoſe exploits which have been matter of aſtoniſhment to all Europe. 16

Enmity between Pruſſia and Auſtria.

It was in this king's reign that Pruſſia firſt perceived her natural enemy and rival to be the houſe of Auſtria, and not France as had been formerly ſuppoſed. Hence frequent bickerings took place between theſe two powers, for which the perſecution of the Proteſtants by ſome of the Catholic ſtates of the empire afforded a pretence; and though a war never actually took place, yet it was eaſy to ſee that both were mortal enemies to each other. But when Frederic William died in 1740, this enmity broke out in full force. The empreſs queen was then left in a very diſagreeable ſituation, as has been obſerved under the article Britain, nº 410, &c. Of this Frederic II. took the advantage to do himſelf juſtice, as he ſaid, with regard to 17

Frederic II. ſeizes Sileſia.

to Sileſia, of which his anceſtors had been unjuſtly deprived. This province he ſeized at that time: but it coſt him dear; for the empreſs, having at laſt overcome all difficulties, formed againſt him the moſt terrible combination that ever was known in Europe.

The treaty was hardly concluded with the king of Pruſſia, by which ſhe reluctantly yielded up the province of Sileſia, and with it a clear revenue of L. 800,000 a-year, before ſhe entered into another

18
Combination againſt him.

with the court of Peterſburg, which was concluded May 22. 1746. This treaty, as far as it was made public, was only of a defenſive nature; but ſix ſecret and ſeparate articles were added to it. By one of theſe it was provided, that in caſe his Pruſſian majeſty ſhould attack the empreſs queen, or the empreſs of Ruſſia, or even the republic of Poland, it ſhould be conſidered as a breach of the treaty of Dreſden, by which Sileſia was given up. It was alſo ſtipulated, that, notwithſtanding that treaty (which indeed had been dictated by the king of Pruſſia himſelf), the right of the empreſs-queen to Sileſia ſtill continued, and for the recovery of that province the contracting powers ſhould mutually furniſh an army of 60,000 men. To this treaty, called the treaty of *Peterſburg*, the king of Poland was invited to accede; but he, being in a manner in the power of the king of Pruſſia, did not think proper to ſign it: however, he verbally acceded to it in ſuch a manner, that the other parties were fully convinced of his deſign to co-operate with all their meaſures; and in conſideration of this intention, it was agreed that he ſhould have a ſhare in the partition of the king of Pruſſia's dominions, in caſe of a ſucceſsful event of their enterpriſes.

In conſequence of theſe machinations, every art was uſed to render the king of Pruſſia perſonally odious to the empreſs of Ruſſia; the queen of Hungary made vaſt preparations in Bohemia and Moravia; and the king of Poland, under pretence of a military amuſement, drew together 16,000 men, with whom he occupied a ſtrong poſt at Pirna. The queen of Hungary, ſtill further to ſtrengthen herſelf, concluded a treaty with the court of France at Verſailles, dated May 1. 1756. But in the mean time, the king of Pruſſia having underſtood by his emiſſaries what was going forward, reſolved to be beforehand with his enemies, and at leaſt

19
He invades Saxony,

to keep the war out of his own country; and therefore entered Saxony with a conſiderable army. At firſt he affected only to demand a free paſſage for his troops, and an obſervance of the neutrality profeſſed by the king of Poland; but, having good reaſons to doubt this neutrality, he demanded, as a preliminary, that theſe Saxon troops ſhould immediately quit the ſtrong poſt they occupied, and diſperſe themſelves. This demand was refuſed; on which his Pruſſian majeſty blockaded the Saxon camp at Pirna, reſolving to reduce it by famine, ſince its ſtrong ſituation rendered an attack very dangerous. At that time there were in Bohemia two Saxon armies, one under the command of M. Brown, and the other under M. Picolomini. To keep theſe in awe, the king had ſent M. Schwerin with an army into Bohemia from the country of Glatz, and M. Keith had penetrated into the ſame kingdom on the ſide of Miſnia. But ſtill the king of Pruſſia did not entirely confide in theſe diſpoſitions; and therefore fearing leſt M. Brown might afford ſome aſſiſtance to the Saxons, he joined his forces under Keith, and on December 1. attacked and defeated the Auſtrian general, ſo that the latter found it impoſſible to relieve the Saxons, who, after a vain attempt to retire from their poſt, were all taken priſoners. The king of Poland quitted his dominions in Germany, and the Pruſſians took up their winter-quarters in Saxony. Here they ſeized on the revenues, levied exorbitant contributions, and obliged the country to furniſh them with recruits. The king of Pruſſia at this time made himſelf maſter of the archives of Dreſden, by which means he procured the originals of thoſe pieces above-mentioned, which, when produced to the world, gave a full proof of the combination that had been formed againſt him, and conſequently juſtified the meaſures he had taken for his own defence.

20
And takes 16,000 priſoners.

21
He is proſecuted in the Aulic council, put to the ban of the empire.

No ſooner had the king entered Saxony, in the manner already related, than a proceſs was commenced againſt him in the emperor's Aulic council, and before the diet of the empire, where he was ſoon condemned for contumacy, and put to the ban of the empire.—The various circles of the empire were ordered to furniſh their contingents of men and money to put this ſentence in execution; but theſe came in ſo ſlowly, that, had it not been for the aſſiſtance of the French under the prince de Soubiſe, the army would probably have never been in a condition to act. The Auſtrians, in the mean time, made great preparations, and raiſed 100,000 men in Bohemia, whom they committed to the care of prince Charles of Lorrain, aſſiſted by M. Brown. The Czarina ſent a body of 60,000 men under M. Apraxin, to invade the Ducal Pruſſia; whilſt a ſtrong fleet was equipped in the Baltic, in order to co-operate with that army. The king of Sweden alſo acceded to the confederacy, in hopes of recovering the poſſeſſions in Pomerania which his anceſtors had enjoyed; and the duke of Mecklenburg took the ſame party, promiſing to join the Swediſh army with 6000 men as ſoon as it ſhould be neceſſary. On the king of Pruſſia's ſide appeared nobody excepting an army of between 30,000 and 40,000 Hanoverians commanded by the duke of Cumberland; and theſe were outnumbered and forced to yield to a ſuperior army of French commanded by M. D'Etrees.

22
Prodigious preparations againſt him.

23
He invades Bohemia and totally defeats the Auſtrian army.

In the mean time, his Pruſſian majeſty, finding that he muſt depend for aſſiſtance ſolely on his own abilities, reſolved to make the beſt uſe of his time. Accordingly, in the ſpring 1757, his armies poured into Bohemia from two different quarters, while the king himſelf prepared to enter it from a third. M. Schwerin entered from Sileſia; the prince of Bevern from Luſatia, where he defeated an army of 28,000 Auſtrians that oppoſed his paſſage. As the intentions of the king himſelf were not known, the Auſtrians detached a body of 20,000 men from their main army to obſerve his motions. This was no ſooner done than the king cut off all communication between the detachment and the main body; and having joined his two generals with incredible celerity, he engaged the Auſtrians near Prague, totally defeated them, took their camp, military cheſt, and cannon; but loſt the brave general Schwerin, who was killed at the age of 82, with a colonel's ſtandard in his hand. On the Auſtrian

ruſſia

ſide, M. Brown was wounded, and died in a ſhort time, though it is ſuppoſed more from the chagrin he ſuffered, than from the dangerous nature of the wound itſelf.

24
ieges
bom-
ds
gue.

About 40,000 of the Auſtrian army took refuge in Prague, while the reſt fled different ways. The city was inſtantly inveſted by the king, and all ſuccours were cut off. The great number of troops which it contained rendered an attack unadviſable, but ſeemed to render the reduction of it by famine inevitable; however, the king, to accompliſh his purpoſe the more ſpeedily, prepared to bombard the town. On the 29th of May, after a moſt dreadful ſtorm of thunder and lightning, four batteries began to play on the city. From theſe were thrown, every 24 hours, 288 bombs, beſides a vaſt number of red-hot balls, ſo that it was ſoon on fire in every quarter. The garriſon made a vigorous defence, and one well-conducted ſally; but had the misfortune to be repulſed with great loſs. The magiſtrates, burghers, and clergy, ſeeing their city on the point of being reduced to an heap of rubbiſh, ſupplicated the commander in the moſt earneſt manner to capitulate; but he was deaf to their intreaties, and drove 12,000 of the moſt uſeleſs mouths out of town, who were quickly driven in again by the Pruſſians.

25
nt
takes
com
d of
Au-
n ar-

Thus the affairs of the empreſs queen ſeemed verging to deſtruction, when Leopold count Daun took upon him the command of the remains of M. Brown's army. This general had arrived within a few miles of Prague the day after the great battle. He immediately collected the ſcattered fugitives with the greateſt diligence, and retired with them to a ſtrong poſt in the neighbourhood, from whence he gave the troops in Prague hopes of a ſpeedy relief. It was now the king of Pruſſia's buſineſs, either to have attempted to make himſelf maſter of the city by one deſperate effort, or entirely to have abandoned the enterpriſe, and driven count Daun from his poſt before his troops had recovered from the terror of their late defeat; but, by attempting to do both, he rendered himſelf incapable of doing either. Though the army of count Daun already amounted to 60,000 men, and though they were ſtrongly entrenched, and defended by a vaſt train of artillery, his majeſty thought proper to ſend no more than 32,000 men. This body made the arduous attempt on the 18th of June; but though they did all that human courage and conduct could do, and though the king himſelf at laſt charged at the head of his cavalry, the Pruſſians were driven out of the field with great loſs. This engagement was named *the battle of Colin*.

26
ats the
ſians at
n.

27
e of
gue
d.

The firſt conſequence of the battle of Colin was, that the king of Pruſſia was obliged to raiſe the ſiege of Prague; ſoon after which, he was obliged to quit Bohemia, and take refuge in Saxony. The Auſtrians haraſſed him as much as poſſible; but, notwithſtanding their great ſuperiority, their armies were not in a condition to make any deciſive attempt upon him, as the frontiers of Saxony abounded with ſituations eaſily defended. In the mean time, the Ruſſians, who had hitherto been very dilatory in their motions, began to exert themſelves, and enter Ducal Pruſſia, under M. Apraxin and Fermor, where they committed innumerable cruelties and exceſſes. A large body of Auſtrians entered Sileſia, and penetrated as far as Breſlau. Then they made a turn backwards, and beſieged Schweidnitz. Another body entered Luſatia, and made themſelves maſters of Zittau. An army of 22,000 Swedes entered Pruſſian Pomerania, took the towns of Anclam and Demmein, and laid the whole country under contribution. The French, too, being freed from all reſtraint by the capitulation of the duke of Cumberland at Cloſter Seven §, made their way into Halbertſtadt and the Old Marche of Brandenburg, firſt exacting contributions, and then plundering the towns. The army of the empire, being reinforced by that of the prince de Soubiſe, after many delays, was on full march to enter Saxony, which left the Auſtrians at liberty to exert the greateſt part of their force in the reduction of Sileſia. General Haddick penetrated through Luſatia, paſſed by the Pruſſian armies, and ſuddenly appeared before the gates of Berlin, which city he laid under contribution. He retired on the approach of a body of Pruſſians; yet he ſtill found means to keep ſuch a poſt as interrupted the king's communication with Sileſia. The deſtruction of the king of Pruſſia therefore now ſeemed inevitable. Every exertion which he had made, though brave and well-conducted, had been unſucceſsful. His general Lehwald, who oppoſed the Ruſſians, had orders to attack them at all events. He obeyed his orders; and with 30,000 men attacked 60,000 of the enemy ſtrongly entrenched at a place called *Norkitten*. The Pruſſians behaved with the greateſt valour; but after having killed five times more of the enemy than they themſelves loſt, they were obliged to retire, though more formidable after their defeat than the Ruſſians after their victory. The king, in the mean time, exerted himſelf on every ſide, and his enemies fled everywhere before him; but whilſt he purſued one body, another gained upon him in ſome other part, and the winter came on faſt, while his ſtrength decayed, and that of his adverſaries ſeemed to increaſe on every quarter.

Pruſſia.

§ See Britain, n° 441.

28
Berlin laid under contribution.

29
Lehwald a Pruſſian general defeated by the Ruſſians.

The Pruſſian monarch, however, though diſtreſſed, did not abandon himſelf to deſpair, or loſe that wonderful preſence of mind which has ſo eminently diſtinguiſhed him in all his military enterpriſes. He induſtriouſly delayed a deciſive action till the approach of winter; but at laſt, after various movements, on November 5. 1757, he met at Roſbach with the united army of his enemies commanded by the prince of Saxe Hilburghauſen and the prince de Soubiſe. The allied army amounted to 50,000 men complete; but moſt of the troops of the Circles were new-raiſed, and many of them not well affected to the cauſe. The Pruſſians did not exceed 25,000 men; but they were ſuperior to any troops in the world, and were inſpired, by the preſence of their king, with the moſt enthuſiaſtic valour. The Auſtrians were defeated with the loſs of 3000 killed, eight generals, 250 officers of different ranks, and 6000 private ſoldiers, taken priſoners, while night alone prevented the total deſtruction of the army.

30
The king gains a great victory at Roſbach.

By this battle the king was ſet free on one ſide; but this only gave him an opportunity of renewing his labours on another. The Auſtrians had a great force, and now began to make a proportionable progreſs in Sileſia. After a ſiege of 16 days, they had reduced the ſtrong fortreſs of Schweidnitz, and obliged the

31 Schweidnitz taken by the Auſtrians.

the Pruſſian garriſon of 4000 men to ſurrender priſoners of war. Hearing then of the victory at Roſbach, and that the king of Pruſſia was in full march to relieve Sileſia, they reſolved to attack the Prince of Bevern in his ſtrong camp under the walls of Breſlau. They attacked the Prince's army on November 22d; but their attack was ſuſtained with the greateſt

32 Battle with the prince of Bevern.

reſolution. The ſlaughter of the Auſtrians was prodigious. A great part of the enemy had retired from the field of battle, and the reſt were preparing to retire, when all at once the Pruſſian generals took the ſame reſolution. Their army had ſuffered much in the engagement, and they became apprehenſive of a total defeat in caſe their intrenchments ſhould be forced in any part; for which reaſon they quitted their ſtrong poſt, and retired behind the Oder. Two days after, the prince of Bevern, going to reconnoitre without eſcort, attended only by a groom, was taken priſoner by an advanced party of Croats, a ſmall body of whom had croſſed the Oder.

33 Breſlau taken by the Auſtrians.

On this the town of Breſlau immediately ſurrendered; where, as well as at Schweidnitz, the Auſtrians found great quantities of proviſions, ammunition, and money. All Sileſia was on the point of falling into their hands, and the Pruſſian affairs were going into the utmoſt diſtraction, when the king himſelf by a moſt rapid march paſſed through Thuringia, Miſnia, and Luſatia, in ſpite of the utmoſt efforts of the generals Haddick and Marſhal, who were placed there to oppoſe him; and, entering Sileſia on the 2d of December, joined the prince of Bevern's corps, who repaſſed the Oder to meet him. The garriſon of Schweidnitz, who, as we have already obſerved, had been made priſoners of war, alſo joined the king's army unexpectedly; and their preſence contributed not a little, notwithſtanding the

34 Garriſon of Schweidnitz recover their liberty.

ſmallneſs of their number, to raiſe the ſpirits of the whole army. They had ſubmitted to the capitulation with the greateſt reluctance; but as the Auſtrians were conducting them to priſon, they happened to receive intelligence of the victory at Roſbach: on which they immediately roſe on the eſcort that conducted them, and entirely diſperſed it; and afterwards marching in ſuch a direction as they thought might moſt readily lead them to their king, they accidentally fell in with his army.

35 Count Daun defeated by the king of Pruſſia at Leuthen.

His Pruſſian majeſty now approached Breſlau; on which the Auſtrians, confiding in their ſuperiority, (for they exceeded 70,000, while the Pruſſians ſcarce amounted to 36,000), abandoned their ſtrong camp, the ſame which the prince of Bevern had formerly occupied, and advanced to give him battle. The king did not intend by any means to diſappoint them, but advanced on his part with the greateſt celerity. The two armies met on December 5th, near the village of Leuthen. Count Daun made the beſt diſpoſitions poſſible. The ground occupied by his army was a plain, with ſmall eminences in ſome parts. Theſe eminences they ſurrounded with artillery; and as the ground was alſo interſperſed with thickets, they ſought to turn theſe likewiſe to their advantage. On their right and left were hills, on which they planted batteries of cannon. The ground in their front was interſected by many cauſeways; and to make the whole more impracticable, the Auſtrians had felled a great number of trees, and ſcattered them in the way. It was almoſt impoſſible at the beginning of the engagement for the Pruſſian cavalry to act, on account of theſe impediments; but, by a judicious diſpoſition made by the king himſelf, all difficulties were overcome. His majeſty had placed four battalions behind the cavalry of his right wing; foreſeeing that General Nadaſti, who was placed on the enemy's left with a corps de reſerve, deſigned to attack him in flank. It happened as he had foreſeen: that general's cavalry attacked the Pruſſian right wing with great fury; but he was received with ſuch a ſevere fire from the four battalions, that he was obliged to retire in diſorder. The king's flank then, well covered and ſupported, was enabled to act with ſuch order and vigour as repulſed the enemy. The Auſtrian artillery was alſo ſilenced by that of the Pruſſians; however, the Auſtrians continued to make a gallant reſiſtance during the whole battle. After having been once thrown into diſorder, they rallied all their forces about Leuthen, which was defended on every ſide by entrenchments and redoubts. The Pruſſians attacked them with the utmoſt impetuoſity, and at laſt became maſters of the poſt; on which the enemy fled on all ſides, and a total rout enſued. In this battle the Auſtrians loſt 6000 killed on the ſpot, 15,000 taken priſoners, and upwards of 200 pieces of cannon.

3[6] Breſl[au] taken.

The conſequences of this victory were very great. Breſlau was immediately inveſted, and ſurrendered on December 29th; the garriſon, amounting to 13,000 men, were made priſoners of war. The blockade of Schweidnitz was formed as cloſely as the ſeaſon of the year would permit; while detached Pruſſian parties over-ran the whole country of Sileſia, and reduced every place of leſs importance. The Ruſſians, who had ravaged and deſtroyed the country in ſuch a manner that they could not ſubſiſt in it, thought proper to retire

3[7] Swe[des] driven out of Po[mera]nia.

out of the Pruſſian dominions altogether. Thus General Lehwald was left at liberty to act againſt the Swedes; and them he quickly drove out of Pruſſian Pomerania, the whole of which country he not only recovered, but alſo ſome part of Swediſh Pomerania. Thus the duchy of Mecklenburg being left quite expoſed, the king took ample vengeance on it by exacting the moſt ſevere contributions of men and money. To complete this monarch's good fortune alſo, the French, who had retired after the battle of Roſbach, were now oppoſed by the Hanoverians under Prince Ferdinand, who kept them ſo well employed, that, during the reſt of the war, the king of Pruſſia had no more trouble from them. See Britain, n° 442.

3[8] Schw[eid]nitz taken.

The beginning of the year 1758 was favourable to the arms of his Pruſſian majeſty. On the 3d of April he commenced his operations againſt Schweidnitz, and puſhed the ſiege ſo vigorouſly, that the place ſurrendered in 13 days. He then diſpoſed his forces in ſuch a manner as might beſt guard his dominions againſt his numerous enemies. For this purpoſe count Dohna commanded a body of troops on the ſide of Pomerania; another conſiderable body was poſted between Wohlau and Glogau, in order to cover Sileſia from the Ruſſians, in caſe they ſhould make their inroad that way. An army, in a little time after, was formed in Saxony, commanded by the king's brother Prince Henry. This army conſiſted of 3 battalions and 45 ſquadrons, and was deſigned to make head againſt the army of the empire; which, by great ef-

Pruſſia.

forts made during the winter, and the junction of a large body of Auſtrians, was again in a condition to act. Between all theſe armies a ready communication was kept up by a proper choice of poſts. After the reduction of Schweidnitz, the king having made a ſhow of invading Bohemia, ſuddenly burſt into Moravia, where in a ſhort time he made himſelf maſter of the
39 whole country, and on the 27th of May laid ſiege to Olmutz the capital. Of this M. Daun was no ſooner informed, than he took his route to Moravia through Bohemia: and, though he was not in a condition to riſk a battle, nor indeed would have done ſo unleſs he had had a very conſiderable advantage; yet, by placing himſelf in a ſtrong ſituation where he could not be attacked, by haraſſing the king's troops and cutting off their convoys, he at laſt obliged him to abandon the enterpriſe. The king, however, who frequently owed a good part of his ſucceſs to the impenetrable ſecrecy with which he covered all his deſigns, gave not the leaſt hint of his intention to raiſe the ſiege of Olmutz. On the contrary, the very day before the ſiege was raiſed, the firing continued as briſk as ever; but in the night (July 1.) the whole army took the road to Bohemia in two columns, and gained an entire march upon the Auſtrians. Thus, notwithſtanding the utmoſt efforts of his enemies, the Pruſſian army reached Bohemia with very little moleſtation. Here he ſeized upon a large magazine at Lieutomiſſel; defeated ſome corps of Auſtrians who had attempted to interrupt his progreſs; and arrived at Konigſgratz, of which he took poſſeſſion, after driving from it 7000 Auſtrians who were intrenched there. This city and ſeveral other diſtricts he laid under contribution: but ſoon after entered Sileſia, and marched with the utmoſt rapidity to encounter the Ruſſians, who had at that time united their forces under generals Brown and Fermor, entered the New Marche of Brandenburg, and laid ſiege to Cuſtrin.

40 The king arrived at this city at a very critical period. The Ruſſians had laid ſiege to it on the 15th of Auguſt; and though they were not well ſkilled in managing artillery, yet, by furious and unremitting diſcharges at random, they threw in ſuch a number of bombs and red-hot balls, that the town was ſoon on fire in every quarter. Some of the wretched inhabitants were burned; others buried in the ruins of their houſes, or killed by the balls which fell like hail in the ſtreets; while many of the ſurvivors abandoned their habitations, and fled out of the town on that ſide where it was not inveſted. The governor did every thing for the defence of the place; but as the walls were built after the old manner, it was impoſſible that the town could have made a defence for any length of time, eſpecially as the principal magazine of the beſieged had been blown up. The avenger of all theſe injuries, however, was now at hand. The king came in ſight of the Ruſſians on the 25th of Auguſt, after a march of 56 days, and beheld the country everywhere deſolated, and the villages in flames by the depredations of his cruel enemy, who had raiſed the ſiege at his ap-
41 proach, and retired towards a neighbouring village named *Zorndorff*. At nine o'clock in the morning, a moſt terrible fire of cannon and mortars poured deſtruction on the right wing of the Ruſſian army for two hours without intermiſſion. The ſlaughter was ſuch as might have been expected; but the Ruſſians kept their ground with aſtoniſhing reſolution, new regiments ſtill preſſing forward to ſupply the places of thoſe that fell. When the firſt line had fired away all their charges, they ruſhed forward on the Pruſſians with their bayonets; and all at once theſe brave troops, though encouraged by the preſence of their king, gave way and fled before an enemy already half defeated. The Ruſſian generals ought now to have attacked with their cavalry the diſordered infantry of their enemies, which would have completed the defeat, and in all probability given the finiſhing ſtroke to the king of Pruſſia's affairs. This opportunity, however, they loſt: but the king was not ſo negligent; for, by a very rapid and maſterly motion, he brought all the cavalry of his right wing to the centre, and falling on the Ruſſian foot uncovered by their horſe, and even diſordered by their own ſucceſs, they puſhed them back with moſt miſerable ſlaughter, at the ſame time that the repulſed battalions of infantry, returning to the charge, and exaſperated at their late diſgrace, rendered the victory no longer doubtful. The Ruſſians were now thrown into the moſt dreadful confuſion. The wind blew the duſt and ſmoke into their faces, ſo that they could not diſtinguiſh friends from foes; they fired on each other, plundered their own baggage which ſtood between the lines, and intoxicated themſelves with brandy: the ranks fell in upon one another; and, being thus crammed together into a narrow ſpace, the fire of the Pruſſians had a full and dreadful effect, while their enemies kept up only a ſcattered and ineffectual fire, generally quite over their heads. Yet even in this diſmal ſituation the Ruſſians did not fly; but ſuffered themſelves to be ſlaughtered till ſeven at night, when their generals having cauſed an attack to be made on the Pruſſian right wing, the attention of the enemy was drawn to that quarter, and they had time to retire a little from the field of battle to recover their order.

In this engagement, which was called the *battle of Zorndorff*, the Ruſſians loſt 21,529 men, while that of the Pruſſians did not exceed 2000. A vaſt train of artillery was taken, together with the military cheſt, and many officers of high rank. The conſequence was, that the Ruſſian army retreated as far as Landſperg on the frontiers of Poland, and the king was left at liberty to march with his uſual expedition to the relief of prince Henry of Saxony.

The Prince was at this time ſorely preſſed by M. Daun. As ſoon as the king had left Bohemia in the manner already related, M. Daun, conſidering that it would have been to no purpoſe to follow him, reſolved to turn his arms towards Saxony. Towards that country, therefore, he took his route through Luſatia, by Zittau, Gorlitz, and Bautzen. On the 3d of September he inveſted the ſtrong fortreſs of Sonneſtein; which unaccountably ſurrendered, after a ſingle day's reſiſtance, to one of his generals named *Macguire*. He then began to favour the operations of General Laudohn, who had advanced through the Lower Luſatia to the confines of Brandenburg; and, by drawing the attention of the Pruſſian forces which were left in Sileſia to the northward of that duchy, he facilitated the progreſs of the generals Harſch and De Ville in the ſouthern parts. He then propoſed that prince Henry ſhould be attacked by the army of the empire, while that of the

42 Operations of Count Daun.

Pruffia. the Auftrians fhould pafs the Elbe, and, falling at the fame time on the Pruffians, fecond the attack of the Imperialifts, and cut off the retreat of their enemies

43 Rendered abortive by the king of Pruffia; from Drefden. The fudden appearance of the king of Pruffia, however, put an end to this plan; general Laudohn abandoned all his conquefts in Lower Lufatia, and retired towards M. Daun, while that general himfelf retired from the neighbourhood of Drefden as far as Zittau. The army of the empire only kept its ground; poffeffing itfelf of the ftrong poft at Pirna, formerly mentioned, but did not undertake any thing. As for the Swedes, who had directed their motions by thofe of the Ruffians, they no fooner heard of the victory of Zorndorff, than they retreated with much more expedition than they had advanced.

Thus the king of Pruffia's affairs feemed to be pretty well retrieved, when by one fatal piece of negligence he was brought to the verge of ruin. M. Daun had poffeffed himfelf of an advantageous camp at Stolphen, by which he preferved a communication with the army of the empire. On the other hand, the king of Pruffia, having taken poffeffion of an important poft at Bautzen, extended his right wing to the village of Hochkirchen, by which he preferved a communication with his brother Prince Henry, protected Brandenburg, and was better fituated than he could be anywhere elfe for throwing fuccours into Silefia. The two armies kept a watchful eye on the motions of each other; and as the principal aim of M. Daun was to cut off the king's communication with Silefia, and of the king to cut off M. Daun's communication with Bohemia, a battle feemed inevitable, though great danger feemed to await that party who fhould begin the attack.

44 Who is furprifed and defeated at Hochkirchen. In this critical pofture of affairs, the Auftrian general formed a defign of attacking the Pruffian camp in the night. In what manner he came to furprife fuch a vigilant enemy, has never been accounted for; but that fuch a furprife was actually accomplifhed on the 14th of October, is certain. In the dead of the preceding night, the Auftrian army began to march in three columns towards the camp of the king of Pruffia: and though the night was exceedingly dark, and they had a confiderable way to go, they all arrived at the fame time, in fafety, without being difcovered, and without the leaft confufion; and at five in the morning began a regular and well-conducted attack. The Pruffians were in a moment thrown into confufion; Marfhal Keith, one of their beft generals, received two mufket-balls, and fell dead on the fpot. Prince Francis of Brunfwick had his head fhot off by a cannon-ball as he was mounting his horfe; and every thing feemed to announce the total deftruction of the army. Still, however, the king preferved his wonderful prefence of mind, which indeed he never appears to have loft on any occafion. He ordered fome detachments from his left to fupport his right wing; but the moment that thefe orders were received, the left itfelf was furioufly attacked. General Ketzow, who commanded in that quarter, repulfed the Auftrians with difficulty, and was not able to afford any confiderable affiftance to the right; which alone was obliged to fuftain the weight of the grand attack. The Auftrians, in the beginning of the engagement, had driven the Pruffians out of the village of Hochkirchen; and as the fate of the day depended on the poffeffion of that poft, the hotteft difpute was there. The Pruffians made three bloody and unfuccefsful attacks on the village; on the fourth they carried it; but the Auftrians continually pouring in frefh troops, at laft drove them out with prodigious flaughter on all fides. The king then ordered a retreat, which was conducted in good order, without being purfued; however, this bloody action coft him 7000 men, together with a great number of cannon. The Auftrians computed their own lofs at 5000.

His Pruffian majefty, having thus happily efcaped fuch imminent danger, took every poffible meafure to prevent the enemy from gaining any confiderable advantage from his defeat. Perceiving that the only advantage they wifhed to derive from it was to cover the operations of their armies in Silefia, and that he had now nothing to fear on the fide of Saxony, he largely reinforced his own army from that of Prince Henry, and haftened into Silefia, in order to raife the fiege of Neifs, which had been completely invefted on the 4th of October. On the 24th of that month, therefore, he quitted his camp, and, making a great compafs, to avoid obftructions from the enemy, arrived in the plains of Gorlitz. A body of the Auftrians had in vain attempted to fecure this poft before him, and fome who arrived after him were defeated with the lofs of 800 men. From this place the king purfued his march with the utmoft diligence; but was followed by general Laudohn, at the head of 24,000 men, who conftantly hung on his rear, and haraffed his army. The king, however, knowing the importance of his expedition, continued his march without interruption, and fuffered his antagonift to obtain many little advantages without moleftation. Daun, however, not content with the oppofition given by Laudohn, fent a large body of horfe and foot by another route to reinforce the generals Karfch and De Ville, who had formed the fiege of Neifs and the blockade of Cofel, while he himfelf paffed the Elbe, and advanced towards Drefden.

All thefe precautions, however, were of little avail. The generals Karfch and De Ville, notwithftanding their reinforcement, no fooner heard of the king of Pruffia's approach, than they raifed the fiege of both places, and retired, leaving behind them a confiderable quantity of military ftores. The end of the Pruffian monarch's march being thus accomplifhed, he inftantly returned by the fame way he came, and haftened to the relief of Saxony, the capital of which (Drefden) was in great danger from Marfhal Daun. The place was but indifferently fortified, and garrifoned only by 12,000 men; fo that it could not promife to hold out long againft a numerous and well-appointed army. It was befides commanded by a large fuburb, of which, if once the enemy got poffeffion, all defence of the city muft then be vain. For this reafon M. Schmettau, the Pruffian governor, determined to fet thefe fuburbs on fire, which was actually done November 10th, with an incredible lofs to the inhabitants, as in the fuburbs were carried on moft of thofe valuable manufactures which render the city of Drefden remarkable. This difappointed the defigns of M. Daun; but, though the action was agreeable to the laws of war, and had been executed with all the caution and humanity of which fuch an action was capable, yet the Auftrians exclaimed againft it as a piece of the moft unprovoked and wanton cruelty recorded in hiftory. 45 Suburbs of Drefden burnt.

After

ruſſia.

46 Saxony oppreſſed by king of Pruſſia.

After the king of Pruſſia had approached Dreſden, all the Auſtrian armies retired into Bohemia, where they took up their winter-quarters, as the king of Pruſſia did in Saxony. This unhappy country he ſaid he would now conſider as his own by right of conqueſt. But inſtead of treating the conquered people as his lawful ſubjects, he oppreſſed them in all poſſible ways, by levying the moſt ſevere and exorbitant contributions, ſurrounding the exchange with ſoldiers, and confining the merchants in narrow lodgings on ſtraw-beds, till they drew upon their correſpondents for ſuch ſums as he wanted.

In 1759, as early as the 23d of February, the Pruſſians commenced their military operations. General Woberſow marched with a body of troops into Poland, where he deſtroyed ſeveral very large magazines belonging to the Ruſſians, and returned into Sileſia without any loſs on the 18th of April. In the mean time, by ſome movements of the king of Pruſſia himſelf, the greateſt part of the Auſtrian troops had been drawn towards the frontiers of Sileſia. Prince Henry immediately took advantage of this opening, and on the 15th of April entered Bohemia with his army divided into two columns. One, commanded by himſelf, marched towards Peterſwade; the other, under general Hulſen, paſſed by the towns of Paſberg and Commottau. That commanded by Prince Henry himſelf penetrated as far as Loboſchutz and Leitmeritz; the enemy flying everywhere before them, and burning or abandoning the vaſt magazines which they had amaſſed in theſe parts. The body under general Hulſen had a more active employment. A ſtrong paſs at Paſberg was defended by a conſiderable body of Auſtrians. General Hulſen, having conducted his cavalry by another way in ſuch a manner as to fall directly on their rear, attacked them in front with his infantry, drove them out of their intrenchments, and totally defeated them with the loſs of a great number killed, and 2000 taken priſoners, while that of the Pruſſians did not exceed 70 in killed and wounded. After this exploit they returned into Saxony, with hoſtages for the contributions which they had largely exacted during the courſe of their expedition.

47 Bohemia invaded by Prince Henry.

48 Body of Auſtrians defeated by General Hulſen.

Some other ſucceſſes obtained by Prince Henry, cleared the country of Franconia of his enemies; but now the approach of the Ruſſians ſeemed once more to bring the affairs of the king of Pruſſia to a criſis. Notwithſtanding the deſtruction of their magazines, they had continued to advance into Sileſia, where they were oppoſed by Count Dohna; but as the troops he had with him were very far inferior to his enemies, he found it impoſſible to do more, at leaſt with any appearance of ſucceſs, than to obſerve their motions and haraſs them on their march. But this was ſo diſpleaſing to the king, that he diſgraced this general, and appointed Wedel to ſucceed him, with orders to attack the Ruſſians at all events. To enable him, however, in ſome meaſure to comply with this deſperate order, he ſent him ſome reinforcements, which brought his army up to near 30,000. With theſe, on the 23d of July 1759, General Wedel attacked 70,000 Ruſſians poſted in the moſt advantageous manner at Zulichau, and defended by a numerous artillery. Though the Pruſſians marched on to certain deſtruction and diſgrace, they ſuſtained the attack for a long time with unparalleled reſolution. At laſt, however, they gave way, and were obliged to retire with the loſs of 4700 killed or taken priſoners, and 3000 wounded.

49 Ruſſians defeated at Zulichau.

Pruſſia.

50 The Ruſſians take Croſſen and Frankfort on the Oder.

The conſequences of this victory were, that the Ruſſians penetrated into the king's territories, and took poſſeſſion of the towns of Croſſen and Frankfort on the Oder, which made it abſolutely neceſſary for the king to come in perſon to oppoſe them. Accordingly, on the 4th of Auguſt, he joined Wedel with a conſiderable body of forces, having left the greateſt part of his army in Saxony under Prince Henry. But as Marſhal Daun had ſent a body of 12,000 horſe and 8000 foot under General Laudohn to the aſſiſtance of the Ruſſians, the king ſtill found himſelf unable to fight them; as, with this and ſome other reinforcements, their army now amounted to upwards of 90,000. He therefore recalled General Finck, whom he had ſent into Saxony with 9000 men; but, with all his reinforcements, it was found impoſſible to augment his army to 50,000 complete. His ſituation, however, was now ſo critical, that a battle was unavoidable; and therefore, on the 12th of Auguſt, with this inferiority of number, the king attacked his enemies ſtrongly intrenched, and defended by a prodigious number of cannon. In this action, his principal effort was againſt the left wing of the Ruſſian army. He began the attack, according to cuſtom, with a heavy cannonade; which having produced the deſired effect, he attacked that wing with ſeveral battalions diſpoſed in columns. The Ruſſian intrenchments were forced with great ſlaughter, and 72 pieces of cannon were taken. But ſtill there was a defile to be paſſed, and ſeveral redoubts which covered the village of Cunnerſdorf to be maſtered. Theſe were attacked with the ſame reſolution, and taken one after another. The enemy made another ſtand at the village, and endeavoured to preſerve their ground there by puſhing forward ſeveral battalions of horſe and foot: but this alſo proved unſucceſsful; they were driven from poſt to poſt quite to the laſt redoubts. For upwards of ſix hours the Pruſſians were ſucceſsful, and everywhere broke the enemy with prodigious ſlaughter; drove them from almoſt all the ground they had occupied before the battle, took more than half their artillery, and ſcarce any thing ſeemed wanting to make the victory complete. In theſe circumſtances, the king wrote the following billet to the queen: "Madam, we have beat the Ruſſians from their intrenchments. In two hours expect to hear of a glorious victory." Of this victory, however, he deprived himſelf, by an exceſſive eagerneſs for conqueſt. The enemy, defeated almoſt in every quarter, found their left wing, ſhattered as it was, to be more entire than any other part of their army. Count Soltikoff, the Ruſſian general, therefore aſſembled the remains of his right wing, and, gathering as many as he could from his centre, reinforced the left, and made a ſtand at a redoubt which had been erected on an advantageous eminence in a place called *the Jews burying-ground*. All the king's generals are ſaid to have been of opinion, that he ought to allow the Ruſſians the peaceable poſſeſſion of this poſt. Their army had already ſuffered ſo much, that it would have been impoſſible for them to have attempted any enterpriſe of conſequence after the battle; but their artillery was ſtill numerous, the poſt very ſtrong, and the Pruſſian troops greatly fatigued. Theſe reaſons for a few moments

51 King of Pruſſia defeated by the Ruſſians at Cunnerſdorf.

Pruffia.

ments had fome weight with the king: but the natural impetuofity of his temper getting the better of his reafon, he led on his wearied troops again and again; till at laft, when their ftrength was in a manner totally exhaufted, they were attacked and utterly routed by the Auftrian and Ruffian cavalry, the former of which had hitherto remained quite inactive, and were therefore quite frefh, and irrefiftible by the enfeebled Pruffians. The night, and the prudent ufe of fome eminences, prevented the total deftruction of the army; however, their lofs amounted to 20,000 men killed and wounded. The king, when he found the victory totally loft, fent another billet to the queen, expreffed in the following manner: "Remove from Berlin with the royal family; let the archives be carried to Potfdam; the town may make conditions with the enemy."

Immediately after this defeat, the king fet himfelf about repairing his loffes with the utmoft diligence. In a few days every thing was again put in order in his camp. He replaced his artillery from Berlin; recalled General Klieft with 5000 men from Pomerania; detached 6000 from his own army to the defence of Saxony; and with the remainder put himfelf between the Ruffians and Great Glogau, covering that city which had been the chief object of their defigns; and in fhort, notwithftanding their victory, obliged them to return to Poland without accomplifhing any thing befides the carnage at Cunnerfdorff.

The misfortunes of the Pruffian monarch, however, were not at an end. Prince Henry indeed, by a moft extraordinary and well-conducted march, entered Saxony, which was now totally over-run by the armies of the enemy. At the fame time, ftrong detachments having been fent into that country under generals Finck and Wunfch, the whole was in a fhort time recovered except Drefden. Towards this place Marfhal Daun retired, and in all probability would foon have been obliged to leave Saxony entirely. But the king's impatience could not be fatisfied without cutting off his retreat, and forcing him to a battle; for which purpofe he fent General Finck with upwards of 12,000 men according to the Pruffian account, but 20,000 according to the Auftrians, to feize fome paffes through which M. Daun could only take his route towards Bohemia.

52 General Finck with 12,000 Pruffians furrenders to the Auftrians.

This commiffion was executed with great exactnefs; but the Pruffian general, having probably advanced too far into thefe defiles, and neglected to preferve a communication with the main army, gave his enemy an opportunity of furrounding him, and at laft forcing him and his whole army to furrender prifoners of war. This difafter was foon after followed by another. General Durceke was pofted at the right of the Elbe, oppofite to Meffen; but on the approach of a large body of Auftrians, they prepared to retreat over the river into a place where they hoped to be more fecure. But having been obliged by an hard froft to withdraw their bridge of boats, a thaw fupervened, when they attempted to lay a bridge of pontoons, fo that they were again obliged to have recourfe to their boats. In this fituation, their rear-guard was attacked with great fury by the Auftrians, and all the foldiers who compofed it killed or taken. The lofs of the Pruffians on this occafion was computed at 3000 men.

The year 1760 fhowed the Pruffian monarch in a more dangerous fituation than he had ever yet experienced. Indeed his affairs now feemed to be altogether defperate.

53 Defperate fituation of the king of Pruffia.

His loffes were not to be meafured by the number of the killed or prifoners, but by armies deftroyed or taken. Forty generals had died or been killed in his fervice fince the beginning of October 1756, exclufive of thofe who were wounded or taken prifoners. This of itfelf would have been an irreparable lofs, had not the very wars which deftroyed thefe furnifhed others equally capable of filling their places. But another deficiency, which could not be remedied, ftill remained.—The king had, by his indefatigable induftry and exertions, fupplied all the deficiencies of men in his armies, but they were not the fame men as before. The hardy veterans, with whom he had originally taken the field, were now no more, and their places were fupplied by others who had neither the fame experience nor difcipline; fo that now he was obliged to fupply this deficiency by his own genius and heroifm.

But whatever abilities the Pruffian monarch might poffefs, and though he undoubtedly exerted them to the utmoft, it feemed only to be contending againft fate, and his enemies gained ftill greater and greater advantages.

54 Pruffians defeated at Landfhut.

General Laudohn, with whom none but the king himfelf feems to have been able to cope, by a feries of artful movements, drew into a difadvantageous fituation M. Fouquet, one of the Pruffian generals, with a ftrong body of forces. Perceiving it impoffible for them to efcape, Laudohn then made a violent attack on their intrenchments in the dead of the night of June 23d. The Pruffians made a gallant defence, but at laft were all killed or taken prifoners except about 300. Of the Pruffians were killed 4000, and 7000 taken prifoners; 58 pieces of cannon, and a great number of colours, were alfo loft. The victory, however, was dear bought; for the Auftrians loft above 12,000 men in killed and wounded; whom, however, they could better fpare than the Pruffians, on account of their numbers.—This action was called *the battle of Landfhut*.

55 Glatz taken by the Auftrians.

Baron Laudohn failed not to improve this victory to the utmoft. He inftantly turned back from Landfhut, and fell upon the city of Glatz; which he took in a very fhort time, with the garrifon who defended it, confifting of 2000 men. In this place were found 101 pieces of brafs cannon, with immenfe quantities of provifions and military ftores. From thence he marched againft Breflau, and immediately invefted it. But, in the mean time, the king of Pruffia, whofe motions had been all this time counteracted by M. Daun in Saxony, marched with his ufual rapidity towards Silefia. By this means he drew M. Daun out of Saxony; and indeed the Auftrian general ufed fuch expedition, that he gained two full days on the king. This was no fooner known to his Pruffian majefty, than he returned with the fame expedition that he had advanced, and fat down before Drefden.

56 Drefden befieged but without fuccefs by the king of Pruffia.

Of this M. Daun foon received intelligence, and returned alfo. In the mean time, however, the buildings of the city were terribly fhattered by the king's cannon and bombs which continually played on it. His endeavours, however, proved ineffectual to reduce it before the arrival of M. Daun. The fiege had been begun on the 13th of July, and on the 19th M. Daun appeared within a league of Drefden. The

Pruſſia

Pruſſians then redoubled their efforts. They had that day received reinforcements of heavy cannon and mortars, with which they battered the place inceſſantly. The cathedral church, New Square, ſeveral principal ſtreets, and ſome palaces, and the noble manufactory of porcelain, were entirely deſtroyed. The ſiege was continued till the 22d: but, on the night of the 21ſt, M. Daun had thrown 16 battalions into the city; which rendered it impoſſible for the king to continue longer before it with any proſpect of ſucceſs. He therefore raiſed the ſiege, and retired without moleſtation, though there were three conſiderable armies of the enemy in the neighbourhood. Breſlau was fiercely bombarded by Laudohn, but the approach of Prince Henry obliged him to deſiſt from his enterpriſe on the 5th of Auguſt.

But, in the mean time, the fortune of the king ſeemed likely to be terminated by one fatal ſtroke. Finding it impoſſible for him to carry on a defenſive war, he marched towards Sileſia with ſuch aſtoniſhing rapidity, that before the middle of Auguſt he had advanced 200 miles, leaving Marſhal Daun with his army far behind him. This expedition he undertook in order to engage General Laudohn before he could have time to effect a junction with Daun and Lacy, another Auſtrian general; which triple union ſeemed to threaten him with unavoidable deſtruction at once. This, however, he found it impoſſible to prevent: and the three armies, when joined, formed a moſt tremendous line of encampments, extending no leſs than 30 Engliſh miles; at the ſame time that every one of their poſts was ſtrong, and the communication between them eaſy. The king was ſtrongly encamped at Lignitz; and for ſeveral days employed all his military ſkill in attempting to induce one of the bodies to detach itſelf from the reſt, or to attack them at ſome diſadvantage; but without effect. At laſt, the Auſtrian generals, having maturely weighed all circumſtances, reſolved to attack the king's camp itſelf, ſtrong as it was; and Marſhal Daun, remembering the advantage he had gained at Hochkirchen by an attack in the night-time, reſolved to follow the ſame plan now. The plan therefore was laid in the following manner. The whole army, as ſoon as it ſhould begin to grow dark, was to march from their ſeveral poſts to ſuch ſituations as were marked out for each corps: they were to ſtrike their tents, but yet to keep up the fires in their camps, and to have the drums beat the tattoo as uſual, by which means they had a probability of ſurpriſing the enemy; or if not, they judged it abſolutely impoſſible for him to eſcape them, though he ſhould be ever ſo much on his guard. In what manner the king of Pruſſia became acquainted with this plan, is not known. His friends attributed it to his own penetration and knowledge of the ſtratagems of war; the Auſtrians, to intelligence given him by deſerters. But, in whatever way he became acquainted with this deſign, it is certain that he took the moſt effectual methods of preventing it. As the Auſtrian plan was to ſurround his camp, and this could not be done without the diviſion of their army which he had ſo long deſired, he reſolved to intercept one of the parties; and if that ſhould be diſabled from acting, he could then more eaſily deal with the other two. Therefore, in the very evening calculated for the deciſive attack on his camp, he quitted it with the utmoſt privacy, and took an advantageous poſt on the road through which General Laudohn was to paſs. The nature of this poſt was ſuch, that at the ſame time that it ſtopped the progreſs of Laudohn in front, Daun would lie under great difficulties if he ſhould attempt his rear; at the ſame time that, for his further ſecurity, the king ſtrengthened the rear with ſeveral batteries. As ſoon as his army was drawn up, he divided it; leaving his right on the ground where it had been formed, to obſerve Marſhal Daun, and to maintain that poſt; whilſt with his left he turned in order to fall on the corps under General Laudohn. In the mean time, that commander, ignorant of the fate which was awaiting him, advanced with the utmoſt expedition towards the place which had been aſſigned him, in order to ſhare in the glory of deſtroying the Pruſſian monarch; when, at three in the morning, on the 15th of Auguſt, a thick fog which covered the ground, ſuddenly clearing up, diſcovered, like the opening of a great ſcene, the dreadful front of the Pruſſian army regularly embattled, and advantageouſly poſted. Laudohn, though ſurpriſed, made the beſt diſpoſitions that circumſtances would admit of, and an obſtinate engagement enſued; in which, however, he was at laſt obliged to yield to the ſuperior ſkill of his adverſary, with the loſs of 10,000 killed, wounded, and priſoners, 82 pieces of cannon, and 23 pair of colours.

57 Three Auſtrian generals join their forces againſt him.

58 He defeats General Laudohn, and intimidates the Ruſſians.

The victory, though complete, gave but a partial relief to the king of Pruſſia. The moſt eſſential ſervice it did was the preventing of the Ruſſians from joining thoſe enemies which he already had. Count Czernichew had been advancing with 24,000 men, and had even paſſed the Oder; but was ſo intimidated by this news, that he inſtantly repaſſed that river on the ſame bridges which he had lately built, even though M. Daun ſent him a ſtrong body of troops in order to encourage him to advance. Soon after this battle, the king joined his brother Prince Henry at New Marche; and marched againſt Daun, who had begun to form the blockade of Schweidnitz, fell upon a corps under General Beck, made two battalions of Croats priſoners, and diſperſed the reſt, which obliged the enemy to abandon the enterpriſe they had juſt undertaken. About the ſame time, General Hulſen gained a conſiderable advantage over the Imperial army in Saxony, with very trifling loſs on his part, by which he effectually prevented them from cutting off his communication with the city of Torgau.

By theſe ſucceſſes the affairs of his Pruſſian majeſty ſeemed to revive: but there was no end of his enemies. The late manœuvres had drawn him ſo far into Sileſia, that his communication with Brandenburg was almoſt wholly cut off. The Ruſſian army, which after it had repaſſed the Oder began to move out of Sileſia, ſent forward a powerful detachment under Count Czernichew towards the march of Brandenburg. A body of 15,000 Auſtrians, under the generals Lacy and Brentano, and the whole united body of Auſtrians and Imperialiſts which acted in Saxony, began their march in concert with the Ruſſians, and propoſed to unite at the gates of Berlin. Theſe armies amounted to 40,000 men. To oppoſe this formidable power, general Hulſen called to his aſſiſtance general Werner, who had been ſent with a body of troops into Pomerania;

Prussia.

rania; but, after being joined by him, their united forces were found not to exceed 15,000 or 16,000 men. To attempt a defence of the capital with this force would have been little short of madness: and therefore these commanders were obliged to leave Berlin to its fate; which indeed, considering the barbarity of the Russians and the animosity of the Austrians, seemed to be a dreadful one. However, by the powerful mediation of several foreign ministers, the town obtained terms which were not altogether intolerable; but the magazines, arsenals, and founderies were destroyed, and an immense quantity of military stores seized, with a number of cannon and other arms. The city was first obliged to pay 800,000 guilders, after which a contribution of 1,900,000 crowns was laid on: yet, notwithstanding this, many violences were committed, and the king's palace was plundered and the furniture abused in a scandalous manner.

59 Berlin taken by the Austrians and Russians.

The combined armies staid in Berlin only four days; dreading the severe vengeance of the king of Prussia, who they heard was advancing towards that place with great expedition. But so great were the embarrassments which now attended that monarch, that it seemed absolutely beyond human power to retrieve his affairs. The Imperialists, on their return from Berlin, having no army to oppose them, made themselves masters of Leipsic, Torgau, Meissen, and Wirtemberg; in which last city they found the grand magazine of the Prussians immensely stored with provisions, ammunition, &c. M. Stainville also, with a detachment from Broglio the French general's army, laid the city and duchy of Halberstadt under contribution. In Eastern Pomerania, the Russians had besieged Colberg by sea and land. In the Western Pomerania, the Swedes advanced with great celerity, hoping to share in the plunder of Berlin. In Silesia, the king no sooner began his march to the northward, than Laudohn advanced, and laid siege to the important fortress of Cosel; and, to complete this distress and embarrassment, the king himself was attended at every step by Count Daun with a superior army well prepared to take every advantage.

60 Extreme embarrassment of the king.

In this desperate situation the king, being joined by his generals Hulsen and prince Eugene of Wittemberg with the corps under their command, advanced up the Elbe, while M. Daun fell back to cover Leipsic and Torgau: but the latter, finding that the Prussians directed their march towards the Elbe, encamped within reach of Torgau; one part of his army extending to the Elbe, by which he was covered on that side, whilst on the other he was covered by hills and woods, so that it was impossible to choose a more advantageous situation. The Prussian army did not amount to 50,000 men, whilst that of the Austrians exceeded 86,000: yet such were the unfortunate circumstances of the king, that he was obliged to fight under all these disadvantages; and therefore he caused his army to be informed, that he was now to lead them to a most desperate attempt, that his affairs required it, and that he was determined to conquer or die. His soldiers unanimously declared that they would die with him.

61 He defeats Count Daun at Torgau

The 3d of November 1760 was the day on which this important affair was decided. The king divided his forces into three columns. General Hulsen was to take post with one in a wood that lay on the left of the Austrian army, and had orders not to move until he found the rest of the Prussians engaged. General Ziethen was to charge on the right; and the great attack in front was to be conducted by the king in person. His forces were disposed in such a manner, that either his right or left must take the enemy in rear and close them in, so as to disable them from undertaking any thing against the part where he intended to effect his principal attack. On the other hand, M. Daun perceiving the king to be serious in his design of fighting, to prevent confusion, sent all his baggage over the Elbe, across which he threw three bridges in case a retreat should be necessary. At the same time he caused Torgau to be evacuated; and then, extending his first line to a village called *Zinne* on the left, he stretched it to another called *Croswitz* on the right; supporting the right of his second line upon the Elbe. In this disposition he was found, when, about two o'clock in the afternoon, the king began his attack. He was received by the fire of 200 pieces of cannon, which were disposed along the Austrian front. The Prussians were thrice led on to the attack; but were every time repulsed and broken with terrible slaughter. The king at length commanded a fresh body of cavalry to advance, which at first compelled the Austrians to retire; but new reinforcements continually coming in, this cavalry was in its turn obliged to fall back, and the Prussians maintained themselves with extreme difficulty, until General Ziethen, with the right wing, attacked the enemy in the rear, repulsed them, and possessed himself of some eminences which commanded the whole Austrian army. Encouraged by this success, the Prussian infantry once more advanced, mastered several of the enemy's intrenchments, and made way for a new attack of their cavalry, which broke in with irresistible fury on the Austrians, and threw several bodies of them into irreparable disorder. It was now about 9 o'clock, and of consequence both armies were involved in thick darkness; yet the fire continued without intermission, and the battalions with a blind rage discharged at one another without distinguishing friend from foe. M. Daun received a dangerous wound in the thigh, and was carried from the field, which probably hastened the defeat of his troops. The command then devolved on Count O'Donnell; who, finding the greatest part of his troops in disorder, the night advanced, and the enemy possessed of some eminences which commanded his camp, and from which it was in vain to think of driving them, ordered a retreat, which was conducted with wonderful order and exactness; none were lost in passing the bridges, and by far the greater part of their artillery was preserved. The loss of the Prussians was estimated at 10,000 killed and wounded, and 3000 taken prisoners. That of the Austrians in killed and wounded is not known; but 8000 were taken prisoners, with 216 officers, among whom were four generals.

62 All Saxony except Dresden recovered.

The consequence of the victory of Torgau was, that the king recovered all Saxony except Dresden; and in the mean time General Werner having marched into Pomerania, the Russians raised the siege of Colberg, and retired into Poland, without having effected any thing further than wasting the open country. Werner then flew to the assistance of Western Pomerania, where he defeated a body of Swedes, and at last drove them totally out of the country. General Laudohn too abruptly raised the blockade of Cosel; and afterwards, abandoning

Prussia.

abandoning Landshut, he retired into the Austrian Silesia, leaving the Prussian part entirely in quiet. M. Daun placed one part of his army in Dresden, and the other in some strong posts which lie to the south and west of it, by which he commanded the Elbe, and preserved his communication with Bohemia. The army of the empire retired into Franconia, and placed its head-quarters at Bamberg.

Though these successes had, to appearance, retrieved the king's affairs in some measure, yet his strength seemed now to be wholly exhausted; and in the campaign of 1761, he made no such vigorous efforts as he had formerly done. The Russians, dividing themselves into two bodies, invaded Silesia and Pomerania. In the former country they laid siege to Breslau, and in the latter to Colberg. Tottleben also, who had commanded the Russian armies, was now removed on a suspicion that he had corresponded with the king of Prussia, and general Romanzow put in his place; by which it was expected that the Russian operations would be more brisk this year than formerly.

The king continued strongly encamped near Schweidnitz; where he was so closely watched by generals Daun and Laudohn, that he could attempt nothing. However, he defeated the designs of the Russians against Breslau, by sending general Platen to destroy their magazines; which he accomplished with great success, at the same time cutting off a body of 4000 of their troops. But this only brought the more sure destruction upon Colberg; to which place that body of Russians immediately marched, cruelly wasting the country as they went along. The king of Prussia could do nothing but send detachments of small parties, which, though they could not oppose their enemies in the field, yet he hoped, by cutting off the convoys of the enemy, might distress them to such a degree as to oblige them to abandon the siege, or at least protract it till the severity

63 Schweidnitz and Colberg retaken.

of the winter should render it impossible for them to carry on their operations. Thus he weakened his own army so much, that it was found requisite to draw 4000 men out of Schweidnitz in order to reinforce it; and no sooner was this done, than general Laudohn suddenly attacked and took that fortress by a coup de main. Colberg made a brave defence; but the troops sent to its relief being totally unable to cope with the Russian army consisting of 50,000 men, it was obliged to surrender on the 3d of December; and thus the fate of the Prussian monarch seemed to be decided, and almost every part of his dominions lay open to the invaders.

64 Empress of Russia dies.

In the midst of these gloomy appearances the empress of Russia, the king's most inveterate and inflexible enemy, died on the 2d of January 1762. Her successor, Peter III. instead of being the king's enemy, was his most sanguine friend. As early as the 23d of February, in a memorial delivered to the ministers of the allied courts, he declared, that, "in order to the establishment of peace, he was ready to sacrifice all the conquests made in this war by the arms of Russia, in hopes that the allied courts will on their parts equally prefer the restoration of peace and tranquillity, to the advantages which they might expect from the continuance of the war, but which they cannot obtain but by a continuance of the effusion of human blood."—This address was not so well relished by the allies: however, they were very willing to make peace, provided it was for their own interest; but they reccommended to his attention fidelity to treaties, which constitutes a no less valuable part of the royal character, than humanity and disinterestedness. This answer made no impression on the czar; a suspension of hostilities took place on the 16th of March, which was followed by a treay of alliance on the 5th of May. In this treaty the czar stipulated nothing in favour of his former confederates; on the contrary, he agreed to join his troops to those of the king of Prussia, in order to act against them. Sweden, which had for a long time acted under the direction of Russian counsels, now followed the example of her mistress, and concluded a peace with Prussia on the 22d of May.

65 Peace between Russia, Sweden, and Prussia.

It is not to be supposed that the king of Prussia would remain long inactive after such an unexpected turn in his favour. His arms were now everywhere attended with success. Prince Henry drove the Imperialists from some important posts in Saxony, by which he secured all that part which the Prussians possessed; and though the Austrians frequently attempted to recover these posts, they were constantly repulsed with great slaughter. The king was not joined by his new allies till the latter end of June; after which he drove M. Daun before him to the extremity of Silesia, leaving the town of Schweidnitz entirely uncovered, and which the king immediately prepared to invest. In the mean time different detachments of Prussians, some on the side of Saxony, and others on that of Silesia, penetrated deep into Bohemia, laid many parts of the country under contribution, and spread an universal alarm. A considerable body of Russian irregulars also made an irruption into Bohemia, where they practised on the Austrians the same cruelties which they had long been accustomed to practise on the Prussians.

66 Successes of the king of Prussia.

67 A new revolution in Russia.

But while the king was thus making the best use of his time, he was all at once threatened with a fatal reverse of fortune by a new revolution in Russia. The emperor was deposed, and his deposition was soon after followed by his death. The empress, who succeeded him, suspected that her husband had been misled by the counsels of his Prussian majesty, against whom, therefore, she entertained a mortal enmity. She could not, however, in the very beginning of her reign, undertake again a war of so much importance as that which had been just concluded. She therefore declared her intention of observing the peace concluded by the late emperor; but, at the same time, of recalling her armies from Silesia, Prussia, and Pomerania; which indeed the unsettled state of the kingdom now made in some degree necessary. At the same time a discovery was made with regard to the king of Prussia himself, which turned the scale greatly in his favour. The Russian senate, flaming with resentment against this monarch, and against their late unfortunate sovereign; and the empress, full of suspicion that the conduct of the latter might have been influenced by the councils of the former, searched eagerly amongst the papers of the late emperor for an elucidation or proofs of this point. They found indeed many letters from the Prussian monarch; but in a strain absolutely different from what they had expected. The king had, as far as prudence would permit, kept a reserve and distance with regard to the too rash advances of this unhappy ally; and, in particular, counselled him to undertake nothing against the

the empreſs his conſort. The hearing of theſe letters read is ſaid to have had ſuch an effect upon the empreſs, that ſhe burſt into tears, and expreſſed her gratitude towards the Pruſſian monarch in the warmeſt terms. Still, however, the Ruſſian army was ordered to ſeparate from the Pruſſians; but all the important places which the former had taken during the whole war were faithfully reſtored.

The king, finding that the Ruſſians were no more to take an active part in his favour, reſolved to profit by their appearance in his camp; and therefore, the very day after the order for their return had arrived, he attacked the Auſtrian army, and drove their right wing from ſome eminences and villages where they were advantageouſly poſted; by which means he entirely cut off their communication with Schweidnitz, ſo that nothing could be attempted for its relief. Prince Henry kept them in continual alarms for Bohemia; and a great part of their attention, and no ſmall part of their forces, were engaged on that ſide. Marſhal Daun, now

68
General Laudohn utterly defeated.

finding himſelf rendered almoſt incapable of undertaking any thing, detached general Laudohn, with a force very much ſuperior, to attack the prince of Bevern, and drive him from the advantageous poſt he occupied. But the prince defended himſelf with ſuch reſolution, that all the efforts of Laudohn could not ſucceed before the king had time to come to his aſſiſtance. The Auſtrians, being then put between two fires, were routed and purſued with terrible ſlaughter; after which, the king met with no more diſturbance in his preparations for the ſiege, and the trenches were opened on the 18th of July. Marſhal Daun made no attempts to relieve the place; but the garriſon being very ſtrong, it held out for near two months from the opening of the trenches. It is ſaid that the attack was conducted, and the defence made, by two engineers who had written on the ſubject of the attack and defence of fortified places; and they were now practically engaged to prove the ſuperiority of their ſyſtems. At laſt, however, the garriſon, to the number of 8000 men, ſurrendered priſoners of war; and the whole body, except nine, were ſoon after drowned at the mouth of the Oder, on their paſſage to their intended confinement at Konigſberg.

The king of Pruſſia, now become maſter of Schweidnitz, turned his attention towards Saxony, where he

69
The total defeat of the Auſtrians at Freyberg produces a peace.

conſiderably reinforced his brother's army, and made preparations for laying ſiege to Dreſden. In this country the Auſtrians had lately met with ſome ſucceſs, and driven Prince Henry back as far as Freyberg; but on the 29th of October, they were attacked by the Pruſſian army thus reinforced, and totally routed. Great numbers were ſlain, and near 6000 taken priſoners. This victory proved deciſive: and the empreſs-queen, finding herſelf deſerted by all her allies, was glad to conclude a treaty; the ſubſtance of which was, that a mutual reſtitution and oblivion ſhould take place, and both parties ſit down at the end of the war in the ſame ſituation in which they began it. This treaty is called the *peace of Hubertſburg*.

The war was no ſooner concluded than the king of Pruſſia turned his attention to domeſtic policy, and the recovery of his dominions from thoſe innumerable calamities which had befallen them during the war. He immediately diſtributed lands to his diſbanded ſoldiers, and gave them the horſes of his artillery to aſſiſt them in their cultivation. By his wiſe and prudent management, the horrors of war were ſoon forgot; and the country was quickly in as flouriſhing a ſtate as ever. Notwithſtanding this pacific diſpoſition, however, the king never ſlackened his endeavours for the defence of his country, by keeping a reſpectable army on foot; which might be able to act on the leaſt emergency.

70
A new comme ces, but produc memor event.

In the year 1778, a new difference with the houſe of Auſtria took place, concerning the duchy of Bavaria. But though the moſt enormous warlike preparations were made on both ſides, and immenſe armies brought into the field, nothing of conſequence was effected. What little advantage there was, ſeems to have been on the Pruſſian ſide, ſince they made themſelves maſters of ſeveral towns, and kept the war in the enemy's country. However, the emperor acted with ſo much caution, and ſhowed ſo much ſkill in a defenſive war, that all the manœuvres of his Pruſſian majeſty could gain no material advantage; as, on the other hand, his adverſary was too wiſe to venture an engagement. A peace therefore was very ſoon concluded, and ſince that time the hiſtory of Pruſſia, during the remainder of the great Frederic's reign, affords no remarkable event which we have not mentioned in the life of that hero, and in the article

71
The gre Frederic ſucceede by his n phew.

Poland. He left his crown to his nephew, whoſe character was not then much developed; and it was eaſily ſeen that a new kingdom, which had riſen ſuddenly to ſuch unexampled power and greatneſs as to excite the jealouſy or apprehenſion of all its neighbours, would require great abilities to preſerve it from diſmemberment.

72
State of nation, a behavio of the n king.

The late king had indeed bequeathed the moſt effectual ſecurities to his ſucceſſor for the preſervation of his dominions, that human wiſdom could provide or deviſe; by leaving him a full treaſury, the fineſt army in the world, and a people enthuſiaſtically attached to his memory and government. The new monarch, with theſe advantages, was not wanting to himſelf. The late king's predilection for the French language and French literature were not grateful to his ſubjects. The preſent ſovereign began his reign with declaring in council, "Germans we are, and Germans I mean we ſhall continue;" giving directions at the ſame time, that their native language ſhould reſume its natural rank and ſtation, from which for near half a century it had been degraded by the French. This was a very popular meaſure, and it was followed by another ſtill more ſo. Obſerving that he had marked with great concern the progreſs of impiety and profaneneſs on the one hand, and of enthuſiaſm on the other, he declared, that he would not have his ſubjects corrupted either by fanatics or atheiſts, and ſtrictly prohibited all publications tending to excite a contempt or indifference for religion.

Such, on his immediate acceſſion to the throne, was the pacific conduct of the monarch, which endeared him to his ſubjects, and commanded the approbation of all good men. An opportunity ſoon occurred, in

73
He aſſiſts the ſtadtholder a gainſt th ſtates of Holland.

which he was thought to have diſplayed ſuch talents in negotiation and in military arrangements, as proclaimed him in every reſpect a worthy ſucceſſor of his uncle. The States of Holland, who had long been jealous of the power of the Stadtholder, and inclined to a republican government without any permanent chief, had gain-

ed

ed ſuch an aſcendancy in the ſtates general, that in 1786 and 1787 they in effect diveſted the prince of Orange of all his prerogatives (ſee *United Provinces*). They proceeded even to the ſeizure and impriſonment of the princeſs, ſiſter to the king of Pruſſia; and depending upon ſupport from France, treated with inſolence every power connected with them in Europe. The court of Berlin did not witneſs theſe proceedings without indignation; and the king formed his plan for reſtoring the power of the Stadtholder with ſuch ſecrecy and prudence, that perhaps nothing could ſurpaſs it but the bravery and military ſkill of the duke of Brunſwick, by whom it was carried into execution. In the ſhort ſpace of one month, that accompliſhed general led 18,000 Pruſſians to Amſterdam, and reſtored the juſt prerogatives of the prince of Orange. And here, we believe, the friends of the houſe of Brandenburg will agree with us, that our hiſtory of Pruſſia ſhould conclude. The monarch's ſubſequent conduct has not been ſuch as the beginning of his reign gave reaſon to expect. Something of it will be ſeen under the article Poland, and more under Revolution and *United Provinces*; and it is not a ſubject upon which we delight to dwell.

74 Soil, population, of Pruſſia.

The air of Pruſſia is wholeſome, and the ſoil fruitful in grain; affording, beſides, plenty of pitcoal and other fuel. The rivers and lakes are well ſtored with fiſh; and amber is found on its coaſt towards the Baltic. The principal rivers are the Viſtula, Bregel, Memel, the Paſſarge, and the Elbe; all of which frequently do damage by their inundations.

The inhabitants of this country were, by Dr Buſching, computed at 635,998 perſons capable of bearing arms; and by another German author, at 450,000. Since the year 1719 it is computed that about 34,000 coloniſts have removed hither from France, Switzerland, and Germany; of which number one half were Saltzburgers. Theſe emigrants have built 400 ſmall villages, 11 towns, 50 new churches, and founded 1000 village-ſchools. The manners of the people differ but little from thoſe of the Germans. The eſtabliſhed religions are thoſe of Luther and Calvin, but chiefly the former; though almoſt all other ſects are tolerated.

75 Commerce manufactures.

The late king of Pruſſia, by the aſſiſtance of an excellent police, brought the commerce and manufactures of this country to a very flouriſhing ſtate, which during his life were daily improving. The manufactures of Pruſſia conſiſt in glaſs, iron-work, paper, gunpowder, copper, and braſs-mills; manufactures of cloth, camblet, linen, ſilk, gold and ſilver lace, ſtockings, and other articles. The inhabitants export variety of naval ſtores; amber, lint-ſeed and hemp-ſeed, oat-meal, fiſh, mead, tallow, and caviar; and it is ſaid that 500 ſhips are loaded with thoſe commodities every year, chiefly from Koningſberg.

76 Situ-

His Pruſſian majeſty is abſolute through all his dominions; but the late king was too wiſe to oppreſs his ſubjects, though he availed himſelf to the full of his power. How the preſent ſovereign treats them we know not, as the whole of his conduct for ſome time paſt has related to the Poliſh and French revolutions. The government of this kingdom is by a regency of four chancellors of ſtate, *viz.* 1. The great-maſter; 2. The great-burgrave; 3. The great-chancellor; and, 4. The great-marſhal. There are alſo ſome other councils, and 37 bailiwicks. The ſtate conſiſts, 1. Of counſellors of ſtate; 2. Of deputies from the nobility; and, 3. From the commons. Beſides theſe inſtitutions, the late king erected a board for commerce and navigation.

77 Revenues.

His Pruſſian majeſty, by means of the happy ſituation of his country, its inland navigation, and the excellent regulations of his predeceſſor, derives an amazing revenue from this country, which, about a century and a half ago, was the ſeat of boors and barbariſm. It is ſaid, that amber alone brings him in 26,000 dollars annually. His other revenues ariſe from his demeſnes, his duties of cuſtoms and tolls, and the ſubſidies yearly granted by the ſeveral ſtates; but the exact ſum is not known, though we may conclude that it is very conſiderable, from the immenſe charges of the late war.

78 Military ſtrength.

The military regulations introduced by the late king had a wonderfully quick operation in forming his troops and recruiting his armies. Every regiment has a particular diſtrict aſſigned it, where the young men proper for bearing arms are regiſtered; and when occaſion offers, they join their regiment, and being incorporated with veterans they ſoon become well diſciplined troops. The Pruſſian army, in time of peace, conſiſts of 175,000 of the beſt diſciplined troops in the world; and during the laſt war, that force was augmented to 300,000 men.

79 Royal arms, &c.

The royal arms of Pruſſia are argent, an eagle diſplayed ſable, crowned, or, for Pruſſia: azure, the Imperial ſceptre, or, for Courland: argent, an eagle diſplayed, gules, with ſemicircular wreaths, for the marquiſate of Brandenburg: to theſe are added the reſpective arms of the ſeveral provinces ſubject to the Pruſſian crown.

There are two orders of knighthood; the firſt, that of the Black Eagle, inſtituted by Frederic I. on the day of his coronation at Koningſberg, with this motto, *Suum cuique*. The ſovereign is always grand-maſter; and the number of knights, excluſive of the royal family, is limited to 30. Next to this is the order of Merit, inſtituted by his late majeſty; the motto is, *Pour le merite*.

PRUSSIAN blue. See Chemistry-*Index*, at *Colouring Matter* and *Pruſſian Blue*.

PRUSSIC acid, according to M. Berthollet, is a combination of azot of hydrogene and carbon. It appears much leſs akin to acids than to ammoniac; it has, however, too many properties in common with other acids not to place it in the ſame claſs, the rather becauſe our claſſifications are always in a degree arbitrary, and ought to be conſidered rather as uſeful methods, than as diviſions formed by nature. When the Pruſſic acid is combined with alkali and oxyd of iron, it cannot be ſeparated by any other acid, unleſs heat be employed, or it be expoſed to light; and neverthleſs, when it is diſengaged by one of theſe means, it cannot ſeparate iron, even from the weakeſt acid, unleſs it be by a double affinity. It appears that this property is connected with the elaſtic ſtate, which is unfavourable to theſe combinations: it muſt have loſt this ſtate, in other words its ſpecific heat muſt be diminiſhed, in order that it may poſſeſs its affinities with metallic oxyds and alkalis. Nitrous gas, oxygenated muriatic acid, and ſulphureous acid, preſent analogous phenomena.

Chemical Annals, vol. i. p. 19, &c.

PRYNNE (William), an Engliſh lawyer, much diſtinguiſhed

distinguished in the civil commotions under Charles I. was born at Swainswick in Somersetshire in 1600. His *Histriomastix*, written against stage-plays in 1632, containing some reflections that offended the court, he was sentenced by the star-chamber to pay a fine of 5000 l. to stand in the pillory, to lose his ears, and to perpetual imprisonment. During his confinement, he wrote several more books; particularly, in 1637, one entitled *News from Ipswich*, which reflecting severely on the bishops, he was again sentenced by the star-chamber to another fine of 5000 l. to lose the remainder of his ears in the pillory, to be branded on both cheeks with S. L. for seditious libeller, and to be perpetually imprisoned in Caernarvon castle. Nothing but cutting off his hands could have prevented Prynne from writing: he wrote still; and in 1640, being set at liberty by the house of commons, he entered London in a kind of triumph, was elected into parliament for Newport in Cornwall, and opposed the bishops with great vigour, being the chief manager of archbishop Laud's trial. In the long parliament he was zealous in the Presbyterian cause; but when the Independents gained the ascendency, he opposed them warmly, and promoted an agreement with the king. When the army garbled the house and refused him entrance, he became a bitter enemy to them and their leader Cromwell, and attacked them with his pen so severely, that he was again imprisoned: but he pleaded the liberty of the subject so successfully, that he was enlarged, to write more controversial books. Being restored to his seat after Cromwell's death, with the other secluded members, he assisted in promoting the restoration, and was appointed keeper of the Tower records; a place excellently well calculated for him, and where he was very useful by the collections he published from them. He presented 40 volumes of his works, in folio and 4to, to Lincoln's-inn library, of which society he was a member; and, dying in 1669, was buried under the chapel.

PRYTANES, in Grecian antiquity, were the presidents of the senate, whose authority consisted chiefly in assembling the senate; which, for the most part, was done once every day.

The senate consisted of 500, 50 senators being elected out of each tribe: after which, lots were cast, to determine in what order the senators of each tribe should preside; which they did by turns, and during their presidentship were called *prytanes*. However, all the 50 prytanes of the tribes did not govern at once, but one at a time, viz. for seven days; and after 35 days, another tribe came into play, and presided for other five weeks; and so of the rest.

PSALM, a divine song or hymn; but chiefly appropriated to the 150 Psalms of David, a canonical book of the Old Testament.

Most of the psalms have a particular title, signifying either the name of the author, the person who was to set it to music or sing it, the instrument that was to be used, or the subject and occasion of it. Some have imagined that David was the sole author of the Book of Psalms; but the titles of many of them prove the contrary, as psalm xix. which appears to have been written by Moses. Many of the psalms are inscribed with the names *Korah*, *Jeduthun*, &c. from the persons who were to sing them.

PSALMANAZAR (George), the fictitious name of a pretended Formosan, a person of learning and ingenuity. He was born in France, and educated in a free-school, and afterwards in a college of Jesuits, in an archiepiscopal city, the name of which, as likewise those of his birth-place and of his parents, are unknown. Upon leaving the college, he was recommended as a tutor to a young gentleman; but soon fell into a mean rambling life, that involved him in disappointments and misfortunes. His first pretence was that of being a sufferer for religion. He procured a certificate that he was of Irish extraction, that he left that country for the sake of the Catholic faith, and was going on a pilgrimage to Rome. Being unable to purchase a pilgrim's garb, and observing one in a chapel, dedicated to a miraculous saint, which had been set up as a monument of gratitude by some wandering pilgrim, he contrived to take both the staff and cloak away; and, being thus accoutred, begged his way in fluent Latin, accosting only clergymen or persons of figure; whom he found so generous and credulous, that, before he had gone 20 miles, he might easily have saved money, and put himself in a much better dress: but as soon as he had got what he thought was sufficient, he begged no more; but viewed every thing worth seeing, and then retired to some inn, where he spent his money as freely as he had obtained it. Having heard the Jesuits speak much of China and Japan, he started the wild scheme, when he was in Germany, of passing for a native of the island of Formosa; and what he wanted in knowledge, he supplied by a pregnant invention. He formed a new character and language on grammatical principles, which, like other oriental languages, he wrote from right to left with great readiness; and planned a new religion, and a division of the year into 20 months, with other novelties, to credit his pretensions. He was now a Japanese convert to Christianity, travelling for instruction, with an appearance more wretched than even that of common beggars. He then entered as a soldier in the Dutch service: but, still desirous of passing for a Japanese, he altered his plan to that of being an unconverted heathen; and at Sluys, brigadier Lauder, a Scots colonel, introduced him to the chaplain, who, with a view of recommending himself to the bishop of London, resolved to carry him over to England. At Rotterdam, some persons having put shrewd questions to him, that carried the air of doubt, he took one more whimsical step, which was to live upon raw flesh, roots, and herbs; which strange food he thought would remove all scruples. The bishop of London patronized him with credulous humanity; and Psalmanazar found a large circle of friends, who extolled him as a prodigy. Yet were there some who entertained a just opinion of him, particularly the Drs Halley, Mead, and Woodward; but their endeavours to expose him as a cheat only made others think the better of him, especially as those gentlemen were esteemed no great admirers of revelation. But in this instance at least, easiness of belief was no great evidence of penetration. He was employed to translate the church-catechism into the Formosan language, which was examined, approved, and laid up as a valuable MS; and the author, after writing his well-known *History of Formosa*, was rewarded and sent to Oxford to study what he liked, while his patrons and opponents were learnedly disputing at London on the merits of his work. The learned members

members of the univerfity were no better agreed in their opinions than thofe at London; but at length the fceptics triumphed. Some abfurdities were difcovered in his hiftory, of fuch a nature as to difcredit the whole narration, and faved him the trouble of an open declaration of his impofture; which however he owned at length to his private friends. For the remainder of his life, his learning and ingenuity enabled him to procure a comfortable fupport by his pen; he being concerned in feveral works of credit, particularly *The Univerfal Hiftory.* He lived irreproachably for many years, and died in 1763.

PSALMIST, in the church of Rome, one of the leffer ecclefiaftical orders; the fame with what among us is called *clerk, precentor,* or *finger.*

PSALMODY, the art or act of finging pfalms. See PSALM.

Pfalmody was always efteemed a confiderable part of devotion, and ufually performed in the ftanding pofture: and as to the manner of pronunciation, the plain fong was fometimes ufed, being a gentle inflection of the voice, not much different from reading, like the chant in cathedrals; at other times more artificial compofitions were ufed, like our anthems.

As to the perfons concerned in finging, fometimes a fingle perfon fung alone; fometimes the whole affembly joined together, which was the moft ancient and general practice. At other times, the pfalms were fung alternately, the congregation dividing themfelves into two parts, and finging verfe about, in their turns. There was alfo a fourth way of finging, pretty common in the fourth century, which was, when a fingle perfon began the verfe, and the people joined with him in the clofe: this was often ufed for variety, in the fame fervice with alternate pfalmody.

The ufe of mufical inftruments, in the finging of pfalms, feems to be as ancient as pfalmody itfelf; the firft pfalm we read of being fung to the timbrel, viz. that of Mofes and Miriam, after the deliverance of the Ifraelites from Egypt: and afterwards, mufical inftruments were in conftant ufe in the temple of Jerufalem. See ORGAN.

PSALTER, the fame with the book of pfalms. See the article PSALM.

Among the religious in the Popifh countries, the term *pfalter* is alfo given to a large chaplet or rofary, confifting of 150 beads, according to the number of pfalms in the pfalter.

PSALTERY, a mufical inftrument, much in ufe among the ancient Hebrews, who called it *nebel.*

We know little or nothing of the precife form of the ancient pfaltery. That now in ufe is a flat inftrument, in form of a trapezium or triangle truncated at top: it is ftrung with 13 wire-chords, fet to unifon or octave, and mounted on two bridges, on the two fides: it is ftruck with a plectrum, or little iron rod, and fometimes with a crooked ftick. Its cheft or body refembles that of a fpinet. See NABLUM and Plate CCCXLIV.

PSAMMETICUS, or PSAMMITICHUS, a renowned conqueror, who, fubduing 11 other petty kings of Egypt, became the founder of the kingdom of Egypt, about 670 B. C. He is memorable likewife for taking the city of Azot, after a fiege of 29 years; and for difcovering the fources of the river Nile. See EGYPT, n° 10.

PSATYRIANS, a fect of Arians, who, in the council of Antioch, held in the year 360, maintained, that the Son was not like the Father as to will; that he was taken from nothing, or made of nothing; and that in God, generation was not to be diftinguifhed from creation.

PSELLUS (Michael), a learned Chriftian of the 11th century, was, by birth, a Conftantinopolitan of confular rank, and flourifhed under the emperor Conftantine Monomachus. His genius and induftry raifed him far above the level of his cotemporaries; and the female hiftorian Anna Comnena fpeaks of him as one who had been more indebted for his attainments to his own excellent talent than to the inftructions of his preceptors; adding, that having made himfelf mafter of all the wifdom of the Greeks and the Chaldeans, he was juftly efteemed the moft learned man of the age. Thus furnifhed, he became the chief inftructor of the Conftantinopolitan youth. He was at the fame time the companion and the preceptor of the emperor, who was fo captivated by the ftudies and amufements in which Pfellus engaged him, that, according to Zonaras, he neglected the concerns of the empire. The Byzantine hiftorians complain, that the emperor, deluded by the head of the philofophers (the title with which Pfellus was honoured), loft the world. Meeting, towards the clofe of his life, with fome difappointment, Pfellus retired into a monaftery, and foon afterwards died; the time of his death is uncertain. His works, which have been much celebrated, are, Commentaries upon Ariftotle's Logic and Phyfics; a Compendium of Queftions and Anfwers; and an Explanation of the Chaldean Oracles. The two latter works prove him to have been converfant, not only with Grecian, but with Oriental, philofophy.

Enfield's Hiftory of Philofophy.

PSEUDO, from ψευδος, a Greek term ufed in the compofition of many words, to denote *falfe* or *fpurious*: as the pfeudo-acacia, or baftard acacia; pfeudo-fumaria, or baftard-fumitory; pfeudo-ruta, or baftard-rue, &c.

We alfo fay, a pfeudo-apoftle, or falfe apoftle; a pfeudo-prophet, or falfe prophet, &c.

PSEUDO-China. See SMILAX.

PSEUDO-Galena, or *Black-Jack.* See ZINC, and MINERALOGY, p. 62.

PSEUDO-Tinea, in natural hiftory, the name of a very remarkable fpecies of infect defcribed by M. Reaumur, approaching to the nature of the *tinea,* or *clothes-moth* while in the worm-ftate, but not making themfelves coats of the fubftance of leaves, cloth, &c. though they form a fort of cafes for their defence againft a very terrible enemy.

Thefe creatures are of the caterpillar kind, and have, in the manner of many of thefe infects, 16 legs. They feed on wax, and for food enter the bee-hives; where they boldly engage the bees, and are not to be prevented by them from feeding, though at the expence of their habitations and the cells of their refervoirs of honey: fo that it is no uncommon thing for a fwarm of bees to be forced to change their place of habitation, and make new combs elfewhere; leaving the old ones to this contemptible victor, whom they know not how to drive out or difpoffefs.

Virgil and Ariftotle, and all the authors who have written on bees, have complained of this deftructive animal. It never eats the honey, but feeds only on the wax; attacking principally thofe waxy cells where the

Pseudo. the female bee deposites her eggs for the future progeny.

The bees, who are a match for most other creatures by means of their stings, would easily destroy these weak creatures, were it not for the impervious armour they are covered with. They form themselves a coat of armour of a double matter. The first, which immediately covers the body, is of a kind of silk of their own spinning; and the outer covering over this is of the bees-wax: this is laid considerably thick; and the creature, just thrusting out its head to feed, goes on devouring the cells undisturbed, while a whole army of the inhabitants are in vain buzzing about him, and attempting to pierce him with their stings. He never forsakes his covering, but lengthens and enlarges it as he goes; and gnawing down the sides of the cells in his march, without staying to eat them one by one, the havock and destruction he occasions are scarce to be conceived. When the time of the change of this creature approaches, it contracts its body within its double covering, and there changes into the nymph state; whence, after a proper time, it comes forth in form of a moth, with granulated horns and a crooked proboscis.

The bees have cunning enough to know their destructive enemy in this new form; and as this is a weak and defenceless state, they attack and destroy all the moths of this species they can meet with. They seldom are so fortunate, however, as to kill the whole race as soon as produced; and if only one escapes, it is able to lay a foundation of revenge for the death of its brethren. All the flies of the moth kind lay a vast number of eggs, and this is behind hand with none of them in that particular: the young ones produced from the eggs of one surviving female of this species are sufficient to destroy many honey-combs; nay, many hives of them. The moth produced by this caterpillar flies but little; yet it is very nimble in avoiding danger, by running, which it does with great swiftness.

There is a species of these pseudo-tineæ, or wax-eating caterpillars, which infest the subterraneous hives of wasps and other creatures which make wax: the manner of living, feeding, and defending themselves from their enemies, is the same in all the species. These last, if they are at any time distressed for food, will eat their own dung; the wax having passed almost unaltered through their bodies, and being still wax, and capable of affording them more nourishment on a second digestion. These species, though they naturally live on this soft food, yet if by any accident they meet with harder only, they know how to live upon it; and can eat a way into the covers and leaves of books, and make themselves cases and coverings of the fragments of these substances. The accurate author † of these observations describes also a kind of *pseudo-tinea* which feeds on wool, and another that eats leather; both making themselves houses also of the materials they feed on.

† *Reaumur's History of Insects.*

There is also another kind very destructive to corn: these make themselves a covering by fastening together a great number of the grains, and there living and eating in secret. All these creatures, whatever be their food or habitation, finally become *phalenæ*, or moths; and may be distinguished, even in this state, from the other species, by having granulated horns of a remarkable structure, and all of them a proboscis, or trunk, more or less incurvated.

Pseudonymus. PSEUDONYMUS, among critics, an author who publishes a book under a false or feigned name; as *cryptonymus* is given to him who publishes one under a disguised name, and *anonymous* to him who publishes without any name at all.

Psittacus. PSIDIUM, the GUAVA: A genus of the monogynia order, belonging to the icosandria class of plants; and in the natural method ranking under the 19th order, *Hesperideæ*. The calyx is quinquefid, superior; there are five petals; the berry is unilocular and monospermous. There are two species: 1. The pyriferum, or white guava; 2. The pomiferum, or red guava. Both these are thought to be only varieties of the same plant. The red guava rises to the height of 20 feet, and is covered with a smooth bark; the branches are angular, covered with oval leaves, having a strong midrib, and many veins running towards the sides, of a light green colour, standing opposite upon very short footstalks. From the wings of the leaves the flowers come out upon footstalks an inch and an half long: they are composed of five large roundish concave petals, within which are a great number of stamina shorter than the petals, and tipped with pale yellow tops. After the flower is past, the germen becomes a large oval fruit shaped like a pomegranate.

A decoction of the roots of guava is employed with success in dysenteries: a bath of a decoction of the leaves is said to cure the itch and other cutaneous eruptions. Guayava, or guava, is distinguished from the colour of the pulp, into the two species above-mentioned, the white and the red; and, from the figure of the fruit, into the round, and the pear-fashioned or perfumed guava. The latter has a thicker rind, and a more delicate taste than the other. The fruit is about the bigness of a large tennis-ball; the rind or skin generally of a russet stained with red. The pulp within the thick rind is of an agreeable flavour, and interspersed with a number of small white seeds. The rind, when stewed, is eaten with milk, and preferred to any other stewed fruit. From the same part is made marmalade; and from the whole fruit is prepared the finest jelly in the world. The fruit is very astringent, and nearly of the same quality with the pomegranate; so should be avoided by all who are subject to costiveness. The seeds are so hard as not to be affected by the fermentation in the stomachs of animals; so that when voided with the excrements, they take root, germinate, and produce thriving trees. Whole meadows in the West Indies are covered with guavas, which have been propagated in this manner. The buds of guava, boiled with barley and liquorice, produce an excellent ptisan for diarrhœas, and even the bloody flux, when not too inveterate. The wood of the tree, employed as fuel, makes a lively, ardent, and lasting fire.

PSITTACUS, or PARROT, in ornithology; a genus belonging to the order of *picæ*. The bill in this genus is hooked from the base; and the upper mandible is moveable: the nostrils are round, placed in the base of the bill, which in some species is furnished with a kind of cere: the tongue is broad, and blunt at one end: the head is large, and the crown flat: the legs are short, the toes placed two before and two behind. It might seem a wonder why nature has destined to this, which is not naturally a bird of prey, but feeds on fruits and vegetable substances, the crooked beak

allotted to the hawk and other carnivorous birds: but the reafon feems to be, that the parrot being a heavy bird, and its legs not very fit for fervice, it climbs up and down trees by the help of this fharp and hooked bill, with which it lays hold of any thing and fecures itfelf before it ftirs a foot; and befides this, it helps itfelf forward very much, by pulling its body on with this hold.

Of all animals, the parrot and crocodile are the only ones which move the upper jaw; all creatures elfe moving the lower only. As fome particular animals befide are fond of particular foods, fo the parrot loves nothing fo much as the feeds of the carthamus, or baftard-faffron; and eats them without any hurt, though they are a purge when given to other creatures.

Parrots are found almoft everywhere within the tropics; and in their natural ftate they live on fruits and feeds, though, when tame, they will eat flefh, and even fifh.

In the Eaft and Weft Indies they are very common, and in fuch warm climates are very brifk and lively; here, however, they lofe much of their vigour. They feldom make nefts, but breed like owls in hollow trees; they lay two eggs. At particular times they fly in very large troops, but ftill they keep two and two together. This genus confifts of infinite variety, not fo much owing to mixture of fpecies, however, as might be fuppofed. They feem to run vaftly into one another, fo as to appear to be related, though received from different parts of the world; this, however, may poffibly be occafioned by their being carried from one place to another for the fake of fale. This uncertainty of native place has prevented Mr Latham from following Buffon's plan, and ranging them according to the places they are fuppofed to inhabit; he divides them therefore into thofe with *uneven* and thofe with *even* tails.

Buffon ranges the parrots in two great claffes: the firft of which comprehends thofe of the Old Continent, and the fecond thofe of the New. The former he fubdivides into five families, the Cockatoos, the Parrots, properly fo called, the Lories, the long-tailed Paroquets, and the fhort-tailed ones; and the latter into fix, viz. the Macaos, the Amazonians, the Creeks, the Popinjays, the long-tailed Paroquets, and the fhort-tailed ones.

Mr Latham has increafed the genus from 47 to 163; and fince the time he wrote his *Index* at leaft 20 more have been difcovered. They are very generally divided into three kinds: 1. The larger, which are as big as a moderate fowl, called *macaos* and *cocketoons;* thefe have very long tails. 2. The middle-fized ones, commonly called *parrots*, which have fhort tails, and are a little larger than a pigeon. And, 3. The fmall ones, which are called *paroquets*, and have long tails, and are not larger than a lark or blackbird.

1. The pfittacus macao, or red and blue macao, is red, except the wing quills, which above are blue, below rufous: the fcapular feathers are variegated with blue and green: the cheeks are naked and wrinkled. It is about two feet feven inches and a half long, and about as big as a capon. Edwards fays, when perfect, it will meafure a full yard from bill to tail. It inhabits Brafil, Guiana, and other parts of South America. It was formerly very common in St Domingo, but is now rarely found there. It generally lives in moift woods, efpecially fuch as are planted with a particular kind of palm, perhaps what is called the *macaw* tree. It does not in general learn to fpeak, and its voice is particularly rough and difagreeable. The flefh is hard, black, and unfavoury, but makes good foup, and is much ufed by the inhabitants of Cayenne and other places. This fpecies, in common with other parrots, is fubject to fits when tamed; and though it will live for many years though the returns be pretty frequent, it generally falls a victim to that difeafe at laft. The Americans call it *gonzalo*. 2. The pfittacus ararauna, or blue and yellow macaw, is blue above, and yellow below, and the cheeks are naked, with feathery lines. It is about the fame fize with the laft, and inhabits Jamaica, Guiana, Brafil, and Surinam. 3. The pfitttacus feverus, or Brafilian green macaw, is black, with a greenifh fplendor; the bill and eyes are reddifh, and the legs are yellow. It is about one foot and five inches long, and is common in Jamaica, Guiana, and Brafil. It is however comparatively rare; but it is extremely beautiful, and of a very amiable and fociable temper when familiar and acquainted; but it can neither bear ftrangers nor rivals: its voice is not ftrong, nor does it articulate very diftinctly the word *ara*. See Plate CCCCXVI.

4. The pfittacus aurora, or yellow amazon, is about 12 inches long, of a green colour, with blue wing quills, and a white front; its orbits are fnowy. It inhabits Mexico or Brafil; but in all probability the latter, from the one which Salerne faw, and which pronounced Portuguefe words. The pfittacus guineenfis, or yellow lory, is about ten inches long, and is an inhabitant of Guinea. The bill is of a black colour; the cere, the throat, and fpace about the eyes, are white; above the eye there is a patch of yellow, and the reft of the head and neck is crimfon. The breaft is yellow, wing coverts green, and the quills are blue, edged with yellow. Under the wings, belly, thighs, vent, and to the under part of the tail, the colour is white, which laft is tipped with red; the legs are dufky, and the claws black. See Plate CCCCXVI.

5. The pfittacus pullarius, red-headed Guinea parraket, or Guinea fparrow, is about five inches and a half long. It inhabits Guinea, and is found in Ethiopia, the Eaft Indies, and the ifland of Java, and fometimes in Surinam. It is green, with a red front, fulvous tail, black bar, and cinereous orbits. The male of this fpecies is peculiarly affectionate to the female. See Plate CCCCXVI.

In Mr White's *Journal of a Voyage to New South Wales*, we find a defcription, with excellent engravings, of feveral fpecies of this extenfive genus; and in Governor Philip's Voyage to the fame place, we find defcriptions and prints of feveral of the fame fpecies. But the moft particular of the later authors are Buffon and Latham, efpecially the laft; to whofe extenfive and accurate work we therefore refer our readers for that information which our limits permit us not to give. See his *Synopfis*, vol. i. p. 194—323. See alfo *Buffon*, vol. vi. p. 63—245.

PSOAS, in anatomy. See there, *Table of the Mufcles*.

PSOPHIA, in ornithology; a genus belonging to the order *gallinæ*. The bill is moderate; the upper mandible is convex; the noftrils are oblong, funk, and pervious; the tongue is cartilaginous, flat, and fringed

at the end; and the legs are naked a little above the knees. The toes are three before and one behind; the last of which is small, with a round protuberance beneath it, which is at a little distance from the ground. Mr Latham only enumerates two species: 1. Psophia crepitans, or gold-breasted trumpeter. Its head and breast are smooth and shining green. By the Spaniards of Maynas it is called *trompetero*, and by the French at Cayenne *agami*, under which last Buffon describes it. It inhabits various parts of South America, Brasil, Guiana, Surinam, &c. but it is most plenty in the Amazons country. It is about 20 inches long, being about the size of a large fowl, and lays eggs rather larger, of a blue green colour. It is met with in the Carribee islands, where it is called a *pheasant*, and its flesh is reckoned as good as that of a pheasant. The most characteristic and remarkable property of these birds consists in the wonderful noise they make either of themselves, or when urged by the keepers of the *menagerie*. Some have supposed it to proceed from the *anus*, and some from the belly. It is now certain, however, that this noise proceeds from the lungs. See Buffon, vol. iv. p. 390, &c. Another very remarkable circumstance is, that they follow people through the streets, and out of town, and that too even perfect strangers. It is difficult to get rid of them; for if you enter a house, they will wait your return, and again join you, though often after an interval of three hours. "I have sometimes (says M. de la Borde) betaken myself to my heels; but they ran faster, and always got before me; and when I stopped, they stopped also.— I know one (continues he) which invariably follows all the strangers who enter his master's house, accompanies them into the garden, takes as many turns as they do, and attends them back again." 2. Psophia undulata, or undulated trumpeter, is about the size of a goose. The upper part of the body is of a pale reddish brown colour, beautifully undulated with black. The head is adorned with a dependent crest. On each side of the neck, beneath the ears, begins a list of black, widening as it descends, and meeting on the lower part before, where the feathers become greatly elongated, and hang loosely down. The under parts are generally white, the legs are of a dusky blue colour, like the bill. It is a native of Africa: Mr Latham's specimen came from Tripoli.

Plate CCCCXVI.

PSORALEA, in botany: A genus of the decandria order, belonging to the diadelphia class of plants; and in the natural method ranking under the 32d order, *Papilionaceæ*. The calyx is powdered, with callous points, and as long as the monospermous legumen.* The most remarkable species are, 1. The primata, or pinnated psoralea, rises with a woody soft stem, branching five or six feet high, pinnated leaves of three or four pair of narrow lobes terminated by an odd one, and at the axillas close-fitting blue flowers with white keels. It is a native of Ethiopia. 2. The bituminosa, or bituminous trifoliate psoralea, rises with a shrubby stalk, branching sparingly about two or three feet high, with ternate or three-lobed leaves of a bituminous scent, and blue flowers in close heads; it grows in Italy and in France. 3. The aculeata, or aculeated prickly psoralea, rises with a shrubby branching stem three or four feet high, with ternate leaves, having wedge-shaped lobes, terminating in a recurved sharp point, and the branches terminated by roundish heads of blue flowers; it grows in Ethiopia. These plants flower here every summer; the first sort greatest part of that season, and the others in July and August; all of which are succeeded by seeds in autumn. Keep them in pots in order for removing into the green-house in winter. They are propagated by seeds, sown in a hot-bed in the spring; and when the plants are two or three inches high, prick them in separate small pots, and gradually harden them to the open air, so as to bear it fully by the end of May or beginning of June. They may also be propagated by cuttings any time in summer, planted in pots, and plunged in a little heat, or covered close with hand-glasses, shaded from the sun, and watered.

PSYCHOTRIA, in botany: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 47th order, *Stellatæ*. The calyx is quinquedentate, persisting, and crowning the fruit; the corolla is tubulated; the berry globose; with two hemispherical fulcated seeds.

The species are four, viz. 1. Aspatica; 2. Serpens; 3. Herbacea; and, 4. Emetica. They are all natives of Jamaica. See Ipecacuanha.

PSYLLI, (Strabo, Ptolemy): a people in the south of Cyrenaica, so called from king Psyllus, (Agathargides, quoted by Pliny): almost all overwhelmed by sand driven by a south wind (Herodotus). They had something in their bodies fatal to serpents, and their very smell proved a charm against them, according to Pliny, Lucan, &c.

Though we may justly look upon it as fabulous, that these people had any thing in their bodies different from others; it is, however, certain that there are in Egypt at this day some persons who have a method of handling the most poisonous serpents without any hurt. Of these Mr Hasselquist gives the following account:

"They take the most poisonous vipers with their bare hands, play with them, put them in their bosoms, and use a great many more tricks with them, as I have often seen. I have frequently seen them handle those that were three or four feet long, and of the most horrid sort. I inquired and examined whether they had cut out the vipers poisonous teeth; but I have with my own eyes seen they do not. We may therefore conclude, that there are to this day Psylli in Egypt; but what art they use is not easily known. Some people are very superstitious, and the generality believe this to be done by some supernatural art which they obtain from invisible beings. I do not know whether their power is to be ascribed to good or evil; but I am persuaded that those who undertake it use many superstitions.

"The art of fascinating serpents is a secret amongst the Egyptians. It is worthy the endeavours of all naturalists, and the attention of every traveller, to learn something decisive as to this affair. How ancient this art is among the Africans, may be concluded from the ancient Marii and Psylli, who were from Africa, and daily showed proofs of it at Rome. It is very remarkable that this should be kept a secret for more than 2000 years, being known only to a few, when we have seen how many other secrets have within that time been revealed.

vealed. The circumftances relating to the fafcination of ferpents in Egypt, related to me, were principally, 1. That the art is only known to certain families, who propagate it to their offspring. 2. The perfon who knows how to fafcinate ferpents, never meddles with other poifonous animals, fuch as fcorpions, lizards, &c. There are different perfons who know how to fafcinate thefe animals; and they again never meddle with ferpents. 3. Thofe that fafcinate ferpents, eat them both raw and boiled, and even make broth of them, which they eat very commonly amongft them; but in particular, they eat fuch a difh when they go out to catch them. I have been told, that ferpents fried or boiled are frequently eat by the Arabians both in Egypt and Arabia, though they know not how to fafcinate them, but catch them either alive or dead. 4. After they have eat their foup, they procure a bleffing from their fcheik (prieft or lawyer), who ufes fome fuperftitious ceremonies, and amongft others, fpits on them feveral times with certain geftures. This manner of getting a bleffing from the prieft is pure fuperftition, and certainly cannot in the leaft help to fafcinate ferpents; but they believe, or will at leaft perfuade others, that the power of fafcinating ferpents depends upon this circumftance."

Notwithftanding this teftimony of Haffelquift, the ftory of the incantation of ferpents, though frequently alluded to in Scripture, has been generally treated as a fable. It is, however, affirmed as a certain truth, both by Mr Bruce and M. Savary. "There is no doubt (fays the former of thefe travellers) of its reality. The Scriptures are full of it. All that have been in Egypt have feen as many different inftances as they chofe. Some have doubted that it was a trick; and that the animals thus handled had been firft trained, and then deprived of their power of hurting; and fond of the difcovery, they have refted themfelves upon it, without experiment, in the face of all antiquity. But I will not hefitate to aver, that I have feen at Cairo (and this may be feen daily without any trouble or expence), a man who came from the catacombs, where the pits of the mummy birds are kept, who has taken a ceraftes with his naked hand from a number of others lying at the bottom of a tub, has put it upon his bare head, covered it with the common red cap he wears, then taken it out, put it in his breaft, and tied it about his neck like a necklace; after which it has been applied to a hen, and bit it, which died in a few minutes; and, to complete the experiment, the man has taken it by the neck, and beginning at his tail, has ate it as one would do a carrot or ftock of celery, without any feeming repugnance.

"We know from hiftory, that where any country has been remarkably infefted with ferpents, there the people have been fcreened by this fecret.

"To leave ancient hiftory, I can myfelf vouch, that all the black people in the kingdom of Sennaar, whether Funge or Nuba, are perfectly armed againft the bite of either fcorpion or viper. They take the ceraftes in their hands at all times, put them in their bofoms, and throw them to one another as children do apples or balls, without having irritated them by this ufage fo much as to bite. The Arabs have not this fecret naturally, but from their infancy they acquire an exemption from the mortal confequences attending the bite of thefe animals, by chewing a certain root, and wafhing themfelves (it is not anointing) with an infufion of certain plants in water."

From this account we fhould be apt to think, that thefe vipers really *would not* bite any who were thus armed againft their poifon; efpecially as he adds, that he "conftantly obferved, that the viper, however lively before, upon being feized by any of thefe barbarians, feemed as if taken with ficknefs and feeblenefs, frequently fhut his eyes, and never turned his mouth towards the arm of the perfon who held him." Yet in another place, fpeaking of the activity of the ceraftes, he fays, "I faw one of them at Cairo, in the houfe of Julian and Rofa, crawl up the fide of a box in which there were many, and there lie ftill, as if hiding himfelf, till one of the people who brought them to us came near him; and though in a very difadvantageous pofture, fticking as it were perpendicularly to the fide of the box, he leaped near the diftance of three feet, and faftened between the man's forefinger and thumb, fo as to bring the blood. The fellow fhowed no figns of either pain or fear, and even kept him with us full four hours, without his applying any fort of remedy, or feeming inclined to do fo."

It is difficult to fee how thefe two accounts can be reconciled. If thofe who catch vipers are in danger of being bit by them *after* they are catched, certainly they muft be fo before, and then the whole relation becomes contradictory. Our author tells us, that thefe feats were performed *for a feafon*, by thofe who were artificially armed againft the viper's poifon, as well as thofe who had the exemption naturally; but though put in poffeffion of the drugs, he never had the courage to make the experiment. That he fhould have made fuch a dreadful experiment on *himfelf*, no perfon in his fenfes would expect; but it is indeed very furprifing, that he did not attempt by means of thefe medicines to arm fome of the brute creatures, of the lives of which he was fufficiently prodigal, againft the effects of that deadly poifon by which fo many of them perifhed.— As furprifing it is, that he did not try what effect the root or its decoction would have upon the ferpents themfelves; or that though he fays he had a fmall quantity of this extraordinary root by him, he gave neither drawing nor defcription of it.

Though it is impoffible to reconcile the particulars of this account to one another, the general fact of the incantation is confirmed by the teftimony of M. Savary. This writer tells us, that he faw at the feaft of Sidi Ibrahim, a troop of people, feemingly poffeffed, with naked arms and a fierce look, holding in their hands enormous ferpents, which twined round their body, and endeavoured to efcape. Thefe Pfylli, grafping them ftrongly by the neck, avoided the bite; and notwithftanding their hiffing, tore them with their teeth, and ate them alive, while the blood ftreamed from their mouth.

PTARMIGAN, in ornithology. See TETRAO.

PTELEA, SHRUB-TREFOIL: A genus of the monogynia order, belonging to the tetrandria clafs of plants; and in the natural method ranking with thofe of which the order is doubtful. The corolla is tetrapetalous; the calyx quadripartite inferior; the fruit is monofpermous, with a roundifh membrane in the middle.

Pteris.

The ſpecies are, 1. The trifoliata, or Carolina ſhrub-trefoil, hath a ſhrubby upright ſtem, dividing into a branchy head eight or ten feet high, covered with a ſmooth purpliſh bark, trifoliate leaves, formed of oval ſpear-ſhaped ſolioles, and the branches terminated by large bunches of greeniſh-white flowers, ſucceeded by roundiſh, bordered capſules. 2. The viſcoſa, or viſcous Indian ptelea, riſes with ſeveral ſtrong ſhrubby ſtems, branching erectly 12 or 15 feet high, having a light brown bark, ſpear-ſhaped, ſtiff, ſimple leaves, and the branches terminated by cluſters of greeniſh flowers.

The firſt ſpecies is a hardy deciduous ſhrub, and a proper plant for the ſhrubbery and other ornamental plantations to increaſe the variety. It is propagated by ſeeds, layers, and cuttings.

The ſecond ſpecies is a ſtove-plant, and is propagated commonly by ſeeds.

PTERIS, in botany; a genus of the order of filices, belonging to the cryptogamia claſs of plants. The fructifications are in lines under the margin. There are 19 ſpecies; the moſt remarkable is the aquilina, or common female fern. The root of this is viſcid, nauſeous, and bitteriſh; and like all the reſt of the fern tribe, has a ſalt, mucilaginous taſte. It creeps under the ground in ſome rich ſoils to the depth of five or ſix feet, and is very difficult to be deſtroyed. Frequent mowing in paſture-grounds, plentiful dunging in arable lands, but, above all, pouring urine upon it, are the moſt approved methods of killing it. It has, however, many good qualities to counterbalance the few bad ones. Fern cut while green, and left to rot upon the ground, is a good improver of land; for its aſhes, if burnt, will yield the double quantity of ſalt that moſt other vegetables will.—Fern is alſo an excellent manure for potatoes; for if buried beneath their roots, it never fails to produce a good crop.—Its aſtringency is ſo great, that it is uſed in many places abroad in dreſſing and preparing kid and chamois leather.—In ſeveral places in the north, the inhabitants mow it green, and, burning it to aſhes, make thoſe aſhes up into balls, with a little water, which they dry in the ſun, and make uſe of them to waſh their linen with inſtead of ſoap. In many of the Weſtern Iſles the people gain a very conſiderable profit from the ſale of the aſhes to ſoap and glaſs makers.—In Glen Elg in Invernesſhire, and other places, the people thatch their houſes with the ſtalks of this fern, and faſten them down with ropes made either of birk-bark or heath. Sometimes they uſe the whole plant for the ſame purpoſe, but that does not make ſo durable a covering.—Swine are fond of the roots, eſpecially if boiled in their waſh.—In ſome parts of Normandy we read that the poor have been reduced to the miſerable neceſſity of mixing them with their bread. And in Siberia, and ſome other northern countries, the inhabitants brew them in their ale, mixing one-third of the roots to two-thirds of malt.—The ancients uſed the root of this fern, and the whole plant, in decoctions and diet-drinks, in chronic diſorders of all kinds, ariſing from obſtructions of the viſcera and the ſpleen. Some of the moderns have given it a high character in the ſame intentions, but it is rarely uſed in the preſent practice. The country people, however, ſtill continue to retain ſome of its ancient uſes; for they give the powder of it to deſtroy worms, and look upon a bed of the green plant as a ſovereign cure for the rickets in children.

Pterocarpus

PTEROCARPUS, in botany: A genus of the decandria order, belonging to the diadelphia claſs of plants; and in the natural method ranking under the 32d order, *Papilionaceæ*. The calyx is quinquedentate, the capſule falcated, filiaceous, varicoſe. The ſeeds are few and ſolitary. There are four ſpecies, viz. 1. *Draco*; 2. *Ecaſtaphyllum*; 3. *Lunatus*; and, 4. *Santalinus*. This laſt is by ſome referred to the genus *Santalum*. It is called *red ſaunders*; and the wood is brought from the Eaſt Indies in large billets, of a compact texture, a dull red, almoſt blackiſh colour on the outſide, and a deep brighter red within. This wood has no manifeſt ſmell, and little or no taſte. It has been commended as a mild aſtringent, and a corroborant of the nervous ſyſtem; but theſe are qualities that belong only to the yellow ſort.

The principal uſe of red ſaunders is as a colouring drug; with which intention it is employed in ſome formulæ, particularly in the *tinctura lavendulæ compoſita*. It communicates a deep red to rectified ſpirit, but gives no tinge to aqueous liquors; a ſmall quantity of the reſin, extracted by means of ſpirit, tinges a large one of freſh ſpirit of an elegant blood-red. There is ſcarcely any oil, that of lavender excepted, to which it communicates its colour. Geoffroy and others take notice, that the Brazil woods are ſometimes ſubſtituted for red ſaunders; and the college of Bruſſels are in doubt whether all that is ſold among them for ſaunders be not really a wood of that kind. According to the account which they have given, their ſaunders is certainly the Brazil wood; the diſtinguiſhing character of which is, that it imparts its colour to water.

PTEROCOCEUS, in botany, is a ſpecies of the genus Calligonum. See CALLIGONUM.

PTERONIA, in botany: A genus of the polygamia equalis order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ*. The receptacle is full of multipartite briſtles; the pappus a little plumy; the calyx imbricated.

PTEROSPERMUM, in botany: A genus of the polyandria order, belonging to the monodelphia claſs of plants; and in the natural method ranking under the 37th order, *Columniferæ*. The calyx is quinquepartite; the corolla conſiſts of five oblong ſpreading petals. The filaments are about 15, which unite towards the baſe into a tube. The ſtyle is cylindrical; the capſule is oval, woody, and quinquelocular, each of which are bivalved, containing many oblong, compreſſed, and winged ſeeds. There is only one ſpecies, viz. the *Pentapetes*, a native of the Eaſt Indies; the wood of which is very hard, and very like that of the holly-tree.

PTINUS, a genus of inſects belonging to the order of coleoptera. The antennæ are filiform: The laſt or exterior articulations are longer than the others: The thorax is nearly round, without a margin, into which the head is drawn back or received: The feet are made for leaping. The moſt remarkable ſpecies are,

1. The pectinicornis. This is produced from a worm that lodges in wood and the trunks of trees, ſuch as the willow, where it makes deep round holes, turns to a winged inſect, takes flight, and rooſts upon flowers. It is diſtinguiſhed by its antennæ pectinated on one

side, whence it has the name of *feathered*. The elytra and thorax are of a deep clay-coloured brown, the antennæ and legs are of a pale brown.

2. The pertinax. The form of this insect resembles the preceding one, saving that its antennæ are filiform. It is all over of a deep blackish brown colour resembling soot. It attacks household-furniture, clothes, furs, and especially animals dried and preserved in collections of natural history, where it makes great havock. When caught, this insect bends its legs, draws back its head, and lies as if it was dead till it thinks itself out of danger. It cannot be forced out of this state of inaction either by pricking or tearing: nothing but a strong degree of heat can oblige it to resume its motion and run away. There are many beautiful varieties of this genus; but they in general escape our attention by their minuteness, and living among hay, dried leaves, and divers other dusty matters, where they undergo their metamorphoses. The larvæ of some are found in trunks of decayed trees, in old tables, chairs, &c. See Plate CCCCXVI.

PTISAN, is properly barley decorticated, or deprived of its hulls, by beating in a mortar, as was the ancient practice; though the cooling potion obtained by boiling such barley in water, and afterwards sweetening the liquor with liquorice-root, is what at present goes by the name of *ptisan;* and to render it laxative, some add a little sena or other ingredient of the same intention.

PTOLEMAIC *System of Astronomy*, is that invented by Claudius Ptolemæus See Ptolemy (Claudius).

PTOLEMAIS, (anc. geog.); the port of Arsinoë, situated on the west branch of the Nile, which concurs to form the island called *Nomos Heracleotes*, to the south of the vertex of the Delta.

Ptolemais, (Strabo); the largest and most considerable town of the Thebais, or Higher Egypt, and in nothing short of Memphis; governed in the manner of a Greek republic; situated on the west side of the Nile, almost opposite to Coptos. This town, which was built by Ptolemy Philadelphus, is now known by the name of *Ptolometa.* The walls and gates are still entire, and there are a vast number of Greek inscriptions, but only a few columns of the portico remain. There is likewise an Ionic temple, done in the most ancient manner of executing that order, of which Mr Bruce took a drawing, which is preserved in the king's collection.—Another, of Cyrenaica, anciently called *Barce.*—A third of the Troglodytica, surnamed *Epitheras*, from the chace of wild beasts, as elephants: lying in the same parallel with Meroë (Strabo); on the Arabian gulf (Pliny); 4820 stadia to the south of Berenice.—A fourth, of Galilee, anciently called *Aca*, or *Acon;* made a Roman colony under the emperor Claudius (Pliny).—A fifth of Pamphylia; situated near the river Melas, on the borders of Cilicia Aspera.

PTOLEMY (Soter, or Lagus), king of Egypt, a renowned warrior, and an excellent prince: he established an academy at Alexandria, and was himself a man of letters. Died 284 B. C. aged 92.

Ptolemy (Philadelphus), his second son, succeeded him to the exclusion of Ptolemy Ceraunus. He was renowned as a conqueror, but more revered for his great virtues and political abilities. He established and augmented the famous Alexandrian library, which had been begun by his father. He greatly increased the commerce of Egypt, and granted considerable privileges to the Jews, from whom he obtained a copy of the Old Testament, which he caused to be translated into Greek, and deposited in his library. This is supposed to have been the version called the *Septuagint.* He died 246 years B. C. aged 64.

Ptolemy (Ceraunus), the elder brother, fled to Seleucus king of Macedon, who received him hospitably; in return for which he assassinated him, and usurped his crown. He then invited Arsinoë, who was his widow and his own sister, to share the government with him; but as soon as he got her in his power, he murdered her and her children. He was at length defeated, killed, and torn limb from limb by the Gauls, 279 B. C.

Ptolemy (Claudius), a celebrated mathematician and astrologer, was born at Pelusium, and surnamed by the Greeks *Most Divine* and *Most Wise.* He flourished at Alexandria in the second century, under the reigns of Adrian and Marcus Aurelius, about the 138th year before the Christian era. There are still extant his Geography, and several learned works on astronomy. The principal of which are, 1. The Almagest; 2. *De Judiciis Astrologicis;* 3. *Planisphærium.* His system of the world was for many years adopted by the philosophers and astronomers; but the learned have rejected it for the system of Copernicus. See Astronomy, n° 16.

PTYALISM, in medicine, a salivation, or frequent and copious discharge of saliva. The word is Greek, formed from πτυω "to spit."

PUBERTY, denotes the age at which a person is capable of procreating or begetting children. See Man, n° 13—18.

Puberty, in law, is fixed at the age of 12 in females, and 14 in males; after which they are reckoned to be fit for marriage. But as to crimes and punishments, the age of puberty is fixed at 14 in both sexes.

PUBES, in anatomy, denotes the middle part of the hypogastric region in men or women, lying between the two inguina or groins.

Section of the Pubes. See Midwifery and *Sigaultian Operation.*

Pubes, in botany, the hair or down on the leaves of some plants. See Hair.

PUBLICAN, among the Romans, one who farmed the taxes and public revenues.

PUBLICATION, the art of making a thing known to the world, the same with promulgation.

PUBLIUS Syrus, a Syrian mimic poet, who flourished about 44 years before Christ. He was originally a slave sold to a Roman patrician, called *Domitius*, who brought him up with great attention, and gave him his freedom when of age. He gained the esteem of the most powerful men at Rome, and reckoned J. Cæsar among his patrons. He soon eclipsed the poet Laberius, whose burlesque compositions were in general esteem. There remains of Publius, a collection of moral sentences, written in iambics, and placed in alphabetical order.

OAK PUCERON, a name given by naturalifts to a very remarkable fpecies of animal of the puceron kind. They bury themfelves in the clefts of the oak and fome other trees, and getting into the crevices, where the bark is a little feparated from the wood, they there live at eafe, and feed to their fill, without being expofed to their common enemies. They are larger than the other pucerons, the winged ones being nearly as large as a common houfe fly; and thofe without wings are alfo larger than any other fpecies of the fame genus. The winged ones are black, and the others of a coffee colour. Their trunk is twice the length of their bodies, and, when walking, it is carried ftraight along the belly, trailing behind it with the point up. When the creature has a mind to fuck a part of the tree that is juft before it, it draws up, and fhortens the trunk, till it brings it to a proper length and direction; but when it fucks in the common way, it crawls upon the inner furface of the bark, and the turned up end of the trunk, which refembles a tail, fixes itfelf againft the wood that is behind it, or contiguous to its back, and fucks there. The extremity of this trunk holds fo faft by the wood, that when it is pulled away, it frequently brings a fmall piece of the wood away with it.

The ants are as fond of thefe as of the other fpecies of pucerons, and that for the fame reafon, not feeding upon them, but on their dung, which is a liquid matter of a fweet tafte, and is the natural juice of the tree, very little altered. Thefe creatures are the fureft guides where to find this fpecies of puceron; for if we at any time fee a number of thefe crawling up an oak to a certain part, and there creeping into the clefts of the bark, we may be affured that in that place there are quantities of thefe oak pucerons. The ants are fo extremely fond of the juices of the tree, when prepared for them by paffing through the body of this animal, that when the puceron has a drop not yet evacuated, but hanging only in part out at the paffage, an ant will often feize on it there.

PUCERONS, *Vine-fretters*, or *Plant-lice*. See APHIS.

PUDENDA, the parts of generation in both fexes. See ANATOMY, n° 107 and 108.

PUERILITY, in difcourfe, is defined by Longinus to be a thought which, by being too far fetched, becomes flat and infipid. Puerility, he adds, is the common fault of thofe who affect to fay nothing but what is brilliant and extraordinary.

PUFFENDORF (Samuel de) was born in 1631 at Fleh, a little village in Mifnia, a province in Upper Saxony; and was fon of Elias Puffendorf, minifter of that place. After having made great progrefs in the fciences at Leipfic, he turned his thoughts to the ftudy of the public law, which in Germany confifts of the knowledge of the rights of the empire over the princes and ftates of which it is compofed, and thofe of the princes and ftates with refpect to each other. But though he ufed his utmoft efforts to diftinguifh himfelf, he defpifed thofe pompous titles which are fo much fought for at univerfities, and never would take the degree of doctor. He accepted the place of governor to the fon of Mr Coyet, a Swedifh nobleman, who was then ambaffador from Sweden to the court of Denmark. For this purpofe he went to Copenhagen, but continued not long at eafe there; for the war being renewed fome time after between Denmark and Sweden, he was feized with the whole family of the ambaffador. During his confinement, which lafted eight months, as he had no books, and was allowed to fee no perfon, he amufed himfelf by meditating on what he read in Grotius's treatife *De Jure Belli et Pacis*, and the political writings of Mr Hobbes. Out of thefe he drew up a fhort fyftem, to which he added fome thoughts of his own, and publifhed it at the Hague in 1660, under the title of *Elementa Jurifprudentiæ Univerfalis*. This recommended him to the elector Palatine, who invited him to the univerfity of Heidelberg, where he founded in his favour a profefforfhip of the law of nature and nations, which was the firft of that kind eftablifhed in Germany. Puffendorf remained at Heidelberg till 1673, when Charles XI. of Sweden gave him an invitation to be profeffor of the law of nature and nations at Lunden; which place the elector Palatine reluctantly allowed him to accept. He went thither the fame year; and after that time his reputation greatly increafed. Some years after, the king of Sweden fent for him to Stockholm, and made him his hiftoriographer, and one of his counfellors. In 1688, the elector of Brandenburg obtained the confent of his Swedifh majefty, that he fhould come to Berlin, in order to write the hiftory of the elector William the Great; and in 1694 made him a baron. But he died that fame year of an inflammation in his feet, occafioned by cutting his nails; having attained his grand climacteric. Of his works, which are numerous, the following are the principal: 1. A Treatife on the Law of Nature and Nations, written in German; of which there is an Englifh tranflation with Barbeyrac's Notes. 2. An Introduction to the Hiftory of the Principal States which at prefent fubfift in Europe; written in German; which has been alfo tranflated into Englifh. 3. The Hiftory of Sweden, from Guftavus Adolphus's expedition into Germany to the abdication of Queen Chriftina. 4. The Hiftory of Charles Guftavus, two volumes folio, &c.

PUFFIN. See ALCA, n° 3.

PUGET (Peter Paul), one of the greateft painters and fculptors France ever produced, though but little noticed by their own writers, was born at Marfeilles in 1623. In his youth he was the difciple of Roman, an able fculptor; and then went to Italy, where he ftudied painting and architecture. In painting he fo well imitated the manner of Peter de Cortona, that this painter defired to fee him, and entered into a friendfhip with him. In 1657, a dangerous diforder obliged him to renounce the pencil, and devote himfelf to fculpture; and his reputation caufing him to be invited to Paris, he enjoyed a penfion of 1200 crowns, as fculptor and director of the works relating to veffels and galleys. He died at Marfeilles in 1695, and has left a number of admirable ftatues behind him both in France and Italy.

PUGIL, in phyfic, &c. fuch a quantity of flowers, feeds, or the like, as may be taken up between the thumb and two fore-fingers. It is reckoned the eighth part of the manipulus or handful.

PULEGIUM, or PENNY-Royal. See MENTHA.

PULEX, the FLEA, in zoology, a genus of infects belonging to the order of aptera. It has two eyes, and

Pulex. and six feet fitted for leaping; the feelers are like threads; the rostrum is inflected, setaceous, and armed with a sting; and the belly is compressed.

The generation of this familiar vermin affords something very curious, first discovered by Sig. Diaciento Cestore. Fleas bring forth eggs, or nits, which they deposit on animals that afford them a proper food: these eggs being very round and smooth, usually slip straight down; unless detained by the piles, or other inequalities, of the clothes, hairs, &c. Of these eggs are hatched white worms, of a shining pearl colour, which feed on the scurfy substance of the cuticle, the downy matter gathered in the piles of clothes, or other the like substances. In a fortnight they come to a tolerable size, and are very lively and active; and, if at any time disturbed, they suddenly roll themselves into a kind of ball. Soon after this, they come to creep, after the manner of silk-worms, with a very swift motion. When arrived at their size, they hide themselves as much as possible, and spin a silken thread out of their mouth, wherewith they form themselves a small round bag, or case, white within as paper, but without always dirty, and fouled with dust. Here, after a fortnight's rest, the animalcule bursts out, transformed into a perfect flea; leaving its exuviæ in the bag. While it remains in the bag, it is milk-white, till the second day before its eruption; when it becomes coloured, grows hard, and gets strength; so that upon its first delivery it springs nimbly away.

The flea, when examined by the microscope, affords a very pleasing object. It is covered all over with black, hard, and shelly scales or plates, which are curiously jointed, and folded over one another in such a manner as to comply with all the nimble motions of the creature. These scales are all curiously polished, and are beset about the edges with short spikes in a very beautiful and regular order. Its neck is finely arched, and much resembles the tail of a lobster: the head also is very extraordinary; for from the snout-part of it there proceed the two fore-legs, and between these is placed the piercer or sucker with which it penetrates the skin to get its food. Its eyes are very large and beautiful, and it has two short horns or feelers. It has four other legs joined all at the breast. These, when it leaps, fold short one within another; and then, exerting their spring all at the same instant, they carry the creature to a surprising distance. The legs have several joints, and are very hairy, and terminate in two long and hooked sharp claws. The piercer or sucker of the flea is lodged between its fore-legs, and includes a couple of darts or lancets; which, after the piercer has made an entrance, are thrust farther into the flesh, to make the blood flow from the adjacent parts, and occasion that round red spot, with a hole in the centre of it, vulgarly called a *flea-bite*. This piercer, its sheath opening sidewise and the two lancets within it, are very difficult to be seen; unless the two fore-legs, between which they are hid, be cut off close to the head: for the flea rarely puts out its piercer, except at the time of feeding, but keeps it folded inwards; and the best way of seeing it is by cutting off first the head, and then the fore-legs, and then it is usually seen thrust out in convulsions.

By keeping fleas in a glass tube corked up at both ends, but so as to admit fresh air, their several actions may be observed, and particularly their way of coupling, which is performed tail to tail; the female, which is much the larger, standing on the male. They may also be thus seen to lay their eggs, not all at once, but ten or twelve in a day, for several days successively; which eggs will be afterwards found to hatch successively in the same order. The flea may easily be dissected in a drop of water; and by this means the stomach and bowels, with their peristaltic motion, may be discovered very plainly, as also their testes and penis, with the veins and arteries, though minute beyond all conception. Mr Lieuwenhoek affirms also, that he has seen innumerable animalcules, shaped like serpents, in the semen masculinum of a flea. This blood-thirsty insect, which fattens at the expence of the human species, prefers the more delicate skin of women; but preys neither upon epileptic persons, nor upon the dead or dying. It loves to nestle in the fur of dogs, cats, and rats. The nests of river-swallows are sometimes plentifully stored with them.

Barbut's Genera of Insects, p. 330, &c.

Fleas are apterous; walk but little, but leap to a height equal to 200 times that of their own body. This amazing motion is performed by means of the elasticity of their feet, the articulations of which are so many springs. Thus it eludes, with surprising agility, the pursuit of the person on whom it riots.—Among the memorabilia of fleas, one, they say, has been seen to draw a small silver piece of ordnance to which it was fastened, the firing of the gun nowise daunting its intrepidity. The owner carried it about in a little box lined with velvet, every now and then placing it on her arm to let it feed; but winter put an end to the being of this martial flea. Another flea that became slave to an Englishman, had, for its daily and easy task, to drag its golden chain and padlock, of the weight of one grain. A third flea served as a thrill-horse to an English artist, who had made an ivory coach and six, that carried a coachman with his dog between his legs, a postilion, two footmen, and four inside riders. At Surat fleas, bugs, and other voracious vermin, are in so great veneration, that they have an hospital endowed, where every night a poor fellow, for hire, suffers himself to be preyed upon. He is fastened naked on a bed, when the feast begins at his expence. In Turkey there is a similar foundation for decayed dogs; an institution less ridiculous than the other. Mercurial ointment, brimstone, a fumigation with the leaves of penny-royal, or fresh-gathered leaves of that plant sewed up in a bag, and laid in the bed, are remedies pointed out as destructive of fleas.

Pulex-*Arboreus*, in natural history, the name given by Mr Reaumur to a very large genus of small animals. They are a kind of half-winged creatures: they have granulated antennæ; and some of them, in their most perfect state, have complete wings. These are distinguished from the others by the name of *musca-pulex* or the *winged-pulex*.

The several species of these creatures are of different colours: some are brown, others yellow; but the most frequent are green. They all feed upon the leaves of trees, which become withered and curled up on their eroding them; and they are so common, that wherever a leaf of a tree is found curled up, or of a different form from the others, it is highly probable these

Pulex.

animals are on it, or that it is their work. Among trees the willow and the rose are the most infected by them; and among plants, the bean and the poppy. They live a social life, multitudes of males and females being found together. The females are easily distinguished from the males, by their being thicker in the body, and having larger bellies.

It is very wonderful, that of all the known animals of the winged kind, these are the only ones which are viviparous. This is easily seen beyond a possibility of doubt; for, on examining a cluster of them together, it is a common thing to see, by the help of a small magnifier, a female in the act of parturition; and the author* of this account frequently saw the young pulex protruded out, from a passage near the anus of the female, perfectly formed. He had suspected this from the total want of eggs among so numerous a tribe of animals, and from their remarkably speedy propagation, and was thus convinced of it by ocular demonstration.

* *Reaumur, History of Insects.*

They are armed with a tender and flexile proboscis; with which they seize hold of the young shoots of the tree they live upon, twisting the proboscis round it. These creatures are always seen naked and exposed, standing on the outside of the stalks and leaves, and sucking in their juices for nourishment with their proboscis. But there is another species of them, which are alike viviparous, and agree with them in all respects except in their manner of living. These get into the inner substance of the leaves, like the worms called *ascarides;* and feed on the parenchyma, being defended from all injuries by living between the integuments. In this case, the leaves they bury themselves in become scabrous and deformed, and produce a sort of galls: so that Malpighi erred in supposing all the galls of trees to be produced by the animals hatched of the eggs of ichneumon flies; since these animals, which are viviparous, and are of a very different kind from the worms of the ichneumon flies, equally produce them. A female of the species here treated of has been seen to bring forth seven young ones in a day: and thus from residing alone in the tubercles which she had formed on a leaf, she in a little time becomes the mother of a numerous family; each of which raises its own tumour or gall on the leaf, which at first are small and round, and of a beautiful red like kermes.

Such of these as are of the male species have a certain time of rest, in which they lie buried in a silky matter, and afterwards become winged, flying nimbly about; whereas the females never are able to fly, but remain always half-winged. It is to be observed, however, that there is a different species of winged insects frequently found flying about the female pulices, as well as their own males; so that all the small-winged insects about them are not to be thought of their own species. These do not greatly differ in figure; but the one are harmless, and the others have stings, and hurt any part of the body on which they fix.

Pulex Aquaticus auctorum (monoculus pulex of Linnæus), in entymology, is a species of the genus Monoculus, which see. It is a most curious insect of the size of a flea, and has been noticed by many writers who have examined its parts with accuracy, and is that which, uniting together in vast numbers, occasions the beautiful red patches which may be observed in a dry summer season on stagnant waters, giving rise to reports of water being turned to blood, and in the minds of the less informed thought to portend dire events. The other species of the same genus collect on waters in a similar way, and occasion a similar appearance, as has been mentioned under the generic name, to which we refer our readers. See also Swammerdam's *Book of Nature,* p. 39.; Baker's *Employment for the Microscope,* p. 302.; Schœffer's *Icon. Inf.*; Sultz. *Inf.* p. 30; De Seer's *Inf.* vol. 7. &c. where there are also excellent figures of it. We have given a figure of it magnified and drawn from life: The outward form of the body, Swammerdam says, is a kind of square; under the eye there is a sharp beak; on the breast are a kind of arms divided into branches like the boughs of trees, and in the abdomen there is a transparent substance with the legs and tail, and in the hinder part of the body, its legs appear placed as it were on the middle of the back: The eyes are almost close together, and are reticulated; the beak is transparent.

Plate CCCCX

It appears that insects of this tribe are enabled to bear the extremes of heat and cold: for Ray, in his *Historia Insectorum,* p. 41. observes, that the *pulex fluviatilis* was met with by Mr Willoughby in a hot bath near Vicenza in Italy, the temperature of which was such as to prevent any other living therein; and, on the contrary, O. Fabricius, in his *Fauna Grœnlandiæ,* p. 264. mentions the circumstance of the *monoculus pulex* being frequently found under the ice in the stagnant waters of Greenland.

The chego, or *pulex minimus, cutem penetrans, Americanus* of Catesby, is a very small animal found in warm climates. It is a very troublesome insect, especially to negroes and such as are slovenly or go barefooted. They penetrate the skin, under which they lay a bunch of eggs, which swell to the bigness of a small pea or tare. They are exceedingly painful; and unless great care is used in taking them out, they are dangerous. It is about one-fourth the size of a common flea; the figure is considerably magnified. From the mouth issues a hollow tube like that of a common flea, between a pair of antennæ. It has six jointed legs, and something like a tail. Under it is one of its eggs, which is scarcely visible to the naked eye. These animals are a great nuisance to most parts of America between the tropics. See Sir Hans Sloane's *History of Jamaica,* Introd. p. cxxiv. and vol. ii. p. 191, 192.

Plate CCCCXV

Pulex-Eaters, a name given by naturalists to a sort of worms frequently found on the leaves of trees, where they devour the animals called *pulices arborei.*

Of these there are several species, which owe their origin to the eggs of different creatures; for there are none of them in their ultimate state in this their time of feeding. According to the different animals whose eggs they are hatched from, these are of different form and structure. Some are hexapodes, or endued with six feet; these belong to the beetle-tribe, and finally change into beetles like the parent animal from whose eggs they sprung. Others have no legs, and are produced from the eggs of flies of various kinds. And, finally, others are genuine caterpillars, though small; but these are the most rare of all.

The two general kinds are the hexapodes, or beetle-worms;

worms; and the apodes, or fly-worms. The fly which gives origin to the last of these is a four-winged one; and takes care always to deposit her eggs in a place where there are plenty of the pulices, usually on the stalk or young branches of a tree in the midst of large families of them. The worm, as soon as hatched, finds itself in the midst of abundance of food, preying at pleasure on these animals, which are wholly defenceless. The stalks of the elder and woodbine are frequently found covered over with these pulices; and among them there may usually be found one or more of these destroyers feeding at will, sucking in the juices from their bodies, and then throwing away the dry skins. Besides the worms of this four-winged fly, there is one of a two-winged wasp-fly, very destructive of these animals.

PULLEY, in mechanics, one of the five mechanical powers. See MECHANICS, p. 739.

PULMO, the LUNGS, in ANATOMY. See there, n° 117.

PULMONARIA, LUNGWORT: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 41st order, *Asperifoliæ*. The corolla is funnel-shaped, with its throat pervious; the calyx is prismatic and pentagonal. There are several species; of which the most remarkable is the officinalis, common spotted lungwort, or Jerusalem cowslip. This is a native of woods and shady places in Italy and Germany, but has been cultivated in Britain for medicinal use. The leaves are of a green colour, spotted with white; and of a mucilaginous taste, without any smell. They are recommended in phthisis, ulcers of the lungs, &c. but their virtues in these diseases are not warranted by experience.

PULO PINANG. See *PRINCE of Wales's Island*.

PULP, in pharmacy, the fleshy and succulent parts of fruits extracted by infusion or boiling, and passed through a sieve.

PULPIT, an elevated place in a church, whence sermons are delivered. The French give the same name to a reading-desk.

PULPITUM, in the Grecian and Roman theatres, was a place where the players performed their parts. It was lower than the scena, and higher than the orchestra. It nearly answered to what we call the stage, as distinguished from the pit and galleries.—*Pulpitum* was also a moveable desk or pulpit, from which disputants pronounced their dissertations, and authors recited their works.

PULSE, in the animal economy, denotes the beating or throbbing of the heart and arteries.

No doctrine has been involved in more difficulties than that of pulses; since, in giving a physiological account of them, physicians have espoused quite opposite sentiments; whilst some doubt whether the pulse is owing to the systole or diastole; as also, whether the motion of the heart and arteries is one and the same, for a moment of time.

With regard to motion, the pulses are reckoned only four; great and little, quick and slow. When quickness and greatness are joined together, it becomes violent; and when it is little and slow it is called a *weak pulse*. They are also said to be *frequent* and *rare*, *equal* and *unequal*; but these are not the essential affections of motion. Frequency and quickness are often confounded with each other. A pulse is said to be *hard* or *soft*, with regard to the artery, according as it is tense, renitent, and hard, or flaccid, soft, and lax: for the disposition of the arteries contributes greatly to the change of the pulse; wherefore it sometimes happens, that the pulse in both arms is not alike, which is very common in a hemiplexy. Add to these a convulsive pulse, which does not proceed from the blood, but from the state of the artery; and is known by a tremulous subsultory motion, and the artery seems to be drawn upwards: this, in acute fevers, is the sign of death; and is said to be the pulse in dying persons, which is likewise generally unequal and intermitting. A *great* pulse shows a more copious afflux of the blood to the heart, and from thence into the arteries; a *little* pulse the contrary.

Pulse.

The pulses of persons differ according to the largeness of the heart and vessels, the quantity and temperies of the blood, the elastic force of the canals; as also with regard to the sex, age, season, air, motion, food, sleep, watchings, and passions of the mind. The pulse is larger and more quick in men than in women; in the bilious and sanguineo-bilious, than in the phlegmatic and melancholic. Those who are lean, with tense fibres and large vessels, have a greater and a stronger pulse, than those that are obese, with lax fibres and small vessels; whence they are more healthy, robust, and apt for labour. In children, the pulse is quick and soft; in adults greater and more violent. In the old, it is commonly great, hard, and slow. Labour, motion, and exercise of the body, increase the circulation of the blood, the excretions, and particularly respiration; rest renders the circulation slow and weak; intense speaking increases the circulation, and consequently renders the pulse large and quick. In watching, the pulse is more evident; in sleep, more slow and languid. After drinking hot things, such as coffee and tea, or hot bath-waters, as well as after meals, the pulse vibrates more quick. But nothing produces a greater change in the pulse than affections of the mind: in terror, it is unequal, small, and contracted; in joy, frequent and great; in anger, quick and hard; in sadness, slow, small, deep, and weak; and in intense study, languid and weak. With regard to the air, when, after the predominancy of a west or south wind, it becomes north or east, the pulse is stronger and larger; as also when the quicksilver rises in the barometer. But when the atmosphere is dense, humid, rainy, with a long south wind; as also where the life is sedentary, the sleep long, and the season autumnal, the pulse is languid and small, and the perspiration decreased. In May it is great, and sometimes violent; in the middle of summer, quick but weak; in the autumn, slow, soft, and weak; in the winter, hard and great. A drastic purge and an emetic render the pulse hard, quick, and weak, with loss of strength; chalybeates, and the bark, render it great and robust, and the complexion lively; volatiles amplify and increase the pulse; acids and nitrous remedies refrigerate the body, and appease the pulse; opiates and the like render it small and weak, and decrease the elasticity of the solids; and poisons render it small, contracted, and hard. When the quantity of the blood is too great, bleeding raises the pulse.

PULSE, is also used for the stroke with which any medium

medium is affected by the motion of light, found, &c. through it.

Sir Isaac Newton demonftrates, that the velocities of the pulfes in an elaftic fluid medium (whofe elafticity is proportionable to its denfity) are in a ratio compounded of half the ratio of the elaftic force directly, and half the ratio of the denfity inverfely; fo that in a medium whofe elafticity is equal to its denfity, all pulfes will be equally fwift.

PULSE, in botany, a term applied to all thofe grains or feeds which are gathered with the hand; in contradiftinction to corn, &c. which are reaped, or mowed: or, It is the feed of the leguminous kind of plants, as beans, vetches, &c. but is by fome ufed for artichokes, afparagus, &c.

PULTENEY (William), the famous oppofer of Sir Robert Walpole in parliament, and afterward earl of Bath, was defcended from one of the moft ancient families in the kingdom, and was born in 1682. Being well qualified in fortune, he early procured a feat in the houfe of commons, and diftinguifhed himfelf as a warm partifan againft Queen Anne's miniftry; whofe errors he had fagacity to detect, and fpirited eloquence to expofe. When King George I. came to the throne, Mr Pulteney was made fecretary at war, and foon after cofferer to the king's houfehold; but the good underftanding between this gentleman and Sir Robert Walpole, who then acted as prime minifter, was interrupted in 1725, on a fufpicion that Walpole was defirous of extending the limits of prerogative, and of promoting the interefts of Hanover, to the prejudice of thofe of Britain. His oppofition to Sir Robert was indeed carried to fuch indifcriminate lengths, that fome have been of opinion he often acted againft meafures beneficial to the public, merely from perfonal motives. It would be impracticable here to trace his parliamentary conduct: fo it muft fuffice to obferve in general, that he became fo obnoxious to the crown, that in 1731 the king called for the council-book, and with his own hand ftruck out his name from the lift of privy-counfellors; a proceeding that only ferved to inflame his refentment and increafe his popularity. Thus he ftill continued to attack the minifter with a feverity of eloquence and farcafm that worfted every antagonift; fo that Sir Robert was heard to declare, he dreaded that man's tongue more than another man's fword. At length, when Walpole found the place of prime minifter no longer tenable, and refigned in 1741, among other promotions Mr Pulteney refumed his place in the privy-council, and was created earl of Bath; a title purchafed at the expence of that popularity which afterward he naturally enough affected to contemn. In 1760, toward the clofe of the war, he publifhed *A Letter to two Great Men*, recommending proper articles to be infifted on in a treaty of peace; which, though the writer was then unknown, was greatly applauded, and went through feveral impreffions. He died in 1764; and as his only fon died before him, the title became extinct.

PULVERIZATION, the art of pulverizing, or reducing a dry body into a fine powder; which is performed in friable bodies by pounding or beating them in a mortar, &c.; but to pulverize malleable ones, other methods muft be taken. To pulverize lead, or tin, the method is this: Rub a round wooden box all over the infide with chalk; pour a little of the melted metal nimbly into the box; when fhutting the lid, and fhaking the box brifkly, the metal will be reduced to powder.

PUMEX, the PUMICE-STONE, a fubftance frequently thrown out of volcanoes, though there are many which are never known to throw it out. It is very full of pores and blifters; in confequence of which it is fpecifically very light, and refembles the frothy flag produced in our iron furnaces. It is of two colours, black and white; the former being that which it has when thrown out of the volcano; the latter, as Cronftedt conjectures, being perhaps faded and bleached. M. Magellan confiders it rather as a volcanic ejection than a volcanic production; and defcribes it as of a white, reddifh-brown, grey, or black colour. It is of a rough and porous confiftence, being made up of flender fibres parallel to each other, and very light, fo that it fwims on water. It ftrikes fire with fteel, though with difficulty, and feems originally to have been an afbeftos decompofed by the action of fire; but, on obferving the appearance of that glaffy flag produced in the iron-furnaces, which entirely refembles the pumice-ftone, and is produced from the calcareous fluxes ufed to promote the fufion of the ore, our author is of opinion that the formation of pumice may be rather attributed to that kind of froth which muft be formed at the top of the melted matters in the volcanic crater. An hundred parts, according to Bergman, contain from 6 to 15 of magnefia, with a fmall proportion of calcareous earth, and the greateft part filex. Another kind of pumice, which feems to be a ferruginous granite altered by fire, has been difcovered by Dolomieu at Stromboli.

Pumice-ftone is ufed in fome mechanical arts; as for rubbing and fmoothing the furface of metals, wood, pafteboard, and ftone; for which it is well fitted by reafon of its harfh and brittle texture; thus fcouring and carrying off the little inequalities from the furfaces juft mentioned,

PUMICE-STONE. See the preceding article.

PUMP, an hydraulic machine for raifing water by means of the preffure of the atmofphere.

Of the invention of pumps.

It would be an entertaining and not an uninftructive piece of information to learn the progreffive fteps by which the ingenuity of man has invented the various methods of raifing water. A pump muft be confidered as the laft ftep of this progrefs. Common as it is, and overlooked even by the curious, it is a very abftrufe and refined invention. Nothing like it has been found in any of the rude nations whom the reftlefs fpirit of the Europeans has difcovered, either in the new continent of America or the iflands of the Pacific Ocean. Nay, it was unknown in the cultivated empire of China at the time of our arrival there by fea; and it is ftill a rarity everywhere in Afia, in places unfrequented by the Europeans. It does not appear to have been known to the Greeks and Romans in early times; and perhaps it came from Alexandria, where phyfical and mathematical fcience was much cultivated by the Greek fchool under the protection of the Ptolemies. The performances of Ctefibius and Hero are fpoken of by Pliny and Vitruvius as curious novelties.

ties (A). It is perhaps not difficult to trace the ſteps by which thoſe mechanicians were led to the invention. The Egyptian wheel was a common machine all over Aſia, and is ſtill in uſe in the remoteſt corners, and was brought by the Saracens into Spain, where it is ſtill very common under its ancient name NORIA. The Daniſh miſſionaries found in a remote village in the kingdom of Siam the immediate offspring of the noria (*Lettres Edifiantes et Curieuſes.*) It was a wheel turned by an aſs, and carrying round, not a ſtring of earthen pots, but a ſtring of wiſps of hay, which it drew through a wooden trunk. This rude chain-pump was in frequent uſe for watering the rice fields. It is highly probable that it is of great antiquity, although we do not recollect its being mentioned by any of the Greek or Roman writers. The Arabs and Indians were nothing leſs than innovators; and we may ſuppoſe with great ſafety, that what arts we now find among them they poſſeſſed in very remote periods. Now the ſtep from this to the pump is but ſhort, though it is nice and refined; and the forcing pump of Cteſibius is the eaſieſt and moſt natural.

Let AB (fig. 1.) be the ſurface of the water in the well, and D the height where it is to be delivered. Let DC be a long wooden trunk, reaching as deep under water as poſſible. Let the rope EF be fitted with its knot of hay F. When it is drawn up through the trunk, it will bring up along with it all the water lying between C and A, which will begin to run out by the ſpout D as ſoon as the knot gets to G, as far below D as C is below A. All this is very obvious; and it required but little reflection to be aſſured, that if F was let down again, or puſhed down, by a rod inſtead of a rope, it would again perform the ſame office. Here is a very ſimple pump. And if it was ever put in practice, it behoved to ſhow the ſupporting power of the atmoſphere, becauſe the water would not only be lifted by the knot, but would even follow it. The imperfection of this pump behoved to appear at firſt ſight, and to ſuggeſt its remedy. By puſhing down the knot F, which we ſhall henceforward call the *piſton*, all the force expended in lifting up the water between A and G is thrown away, becauſe it is again let down. A valve G, at the bottom, would prevent this. But then there muſt be a paſſage made for the water by a lateral tube KBD (fig. 2.) And if this be alſo furniſhed with a valve H, to prevent its loſing the water, we have the pump of Cteſibius, as ſketched in fig. 2. The valve is the great refinement: but perhaps even this had made its appearance before in the noria. For, in the more perfect kinds of theſe machines, the pots have a ſtop or valve in their bottom, which hangs open while the pot deſcends with its mouth downwards, and then allows it to fill readily in the ciſtern; whereas, without the valve, it would occaſion a double load to the wheel. If we ſuppoſe that the valve had made its appearance ſo early, it is not improbable that the common pump ſketched in fig. 3. was as old as that of Cteſibius. For a further deſcription of the pump of Cteſibius as it was uſed by the ancients, and of thoſe pumps which have been deduced from it and are now in common uſe, see HYDROSTATICS n° 28—32. In this place we ſhall firſt give a ſhort deſcription of the chief varieties of theſe engines, conſidering them in their ſimpleſt form, and we ſhall explain in very general terms their mode of operation. We ſhall then give a conciſe and popular theory of their operation, furniſhing principles to direct us in their conſtruction; and we ſhall conclude with the deſcription of a few peculiarities which may contribute to their improvement or perfection.

There are but two ſorts of pumps which eſſentially differ; and all the varieties that we ſee are only modifications of theſe. One of theſe original pumps has a ſolid piſton; the other has a piſton with a perforation and a valve. We uſually call the firſt a FORCING PUMP, and the ſecond a LIFTING or SUCKING PUMP.

3 Forcing pump deſcribed.

Fig. 2. is a ſketch of the forcing pump in its moſt ſimple form and ſituation. It conſiſts of a hollow cylinder ACca, called the WORKING BARREL, open at both ends, and having a valve G at the bottom, opening upwards. This cylinder is filled by a ſolid piſton EF, covered externally with leather or tow, by which means it fits the box of the cylinder exactly, and allows no water to eſcape by its ſides. There is a pipe KHD, which communicates laterally with this cylinder, and has a valve at ſome convenient place H, as near as poſſible to its junction with the cylinder. This valve alſo opens upwards. This pipe, uſually called the RISING PIPE, or MAIN, terminates at the place D, where the water muſt be delivered.

4 Its mode of operation.

Now ſuppoſe this apparatus ſet into the water, ſo that the upper end of the cylinder may be under or even with the ſurface of the water AB; the water will open the valve G, and after filling the barrel and lateral pipe, will alſo open the valve H, and at laſt ſtand at an equal height within and without. Now let the piſton be put in at the top of the working barrel, and thruſt down to K. It will puſh the water before it. This will ſhut the valve G, and the water will make its way through the valve H, and fill a part B*b* of the riſing pipe, equal to the internal capacity of the working barrel. When this downward motion of the piſton ceaſes, the valve H will fall down by its own weight and ſhut this paſſage. Now let the piſton be drawn up again: The valve H hinders the water in the

(A) In the early Greek writings, it does not appear that the words ἀντλος, ἀντλεῖν, ἀντλια, &c. were uſed to expreſs any thing like what we call a pump. In all theſe paſſages the words either expreſs generally the drawing of water, or, more particularly, the drawing it with a bucket or ſomething ſimilar. Ἀντλος, which is the primitive, is a drain, ſink, or receptacle for collecting ſcattered water, either for uſe, or to get rid of it; hence it came to ſignify the ſink or well of a ſhip; and ἀντλεῖν was ſynonymous with our verb "to bale the boat." (*Odyſſ.* O. 476. M. 411. *Euryp. Hecuba*, 1025). Ἀντλιον is the *veſſel* or *bucket* with which water is drawn. Ἀντλια is the ſervice (generally a puniſhment) of drawing water. Ἀντλεῖν, "to draw water with a bucket": hence the force of Ariſtotle's expreſſion (*Oecon.* 1) τω γαρ ἠθμῷ ἀντλειν τουτ' ἐςι. See even the late authority of the New Teſtament, John ii. 8.; iv. 7. 11. Here ἀντλημα is evidently ſomething which the woman brought along with her; probably a bucket and rope.

Pump.

the rising pipe from returning into the working barrel. But now the valve G is opened by the pressure of the external water, and the water enters and fills the cylinder as the piston rises. When the piston has got to the top, let it be thrust down again: The valve G will again be shut, and the water will be forced through the passage at H, and rise along the main, pushing before it the water already there, and will now have its surface at L. Repeating this operation, the water must at last arrive at D, however remote, and the next stroke would raise it to *e*; so that during the next rise of the piston the water in *e*D will be running off by the spout.

The effect will be the same whatever is the position of the working barrel, provided only that it be under water. It may lie horizontally or sloping, or it may be with its mouth and piston rod undermost. It is still the same forcing pump, and operates in the same manner and by the same means, viz. the pressure of the surrounding water.

The external force which must be applied to produce this effect is opposed by the pressure exerted by the water on the opposite face of the piston. It is evident, from the common laws of hydrostatics, that this opposing pressure is equal to the weight of a pillar of water, having the face of the piston for its base, and the perpendicular height *d*A of the place of delivery above the surface of the water AB in the cistern for its height. The form and dimensions of the rising pipe are indifferent in this respect, because heavy fluids press only in the proportion of their perpendicular height. Observe that it is not *d*F, but *d*A, which measures this pressure, which the moving force must balance and surmount. The whole pressure on the under surface F*f* of the piston is indeed equal to the weight of the pillar *d*F*fs*; but part of this is balanced by the water AF*fa*. If indeed the water does not get into the upper part of the working barrel, this compensation does not obtain. While we draw up the piston, this pressure is removed, because all communication is cut off by the valve H, which now bears the whole pressure of the water in the main. Nay, the ascent of the piston is even assisted by the pressure of the surrounding water. It is only during the descent of the piston therefore that the external force is necessary.

Observe that the measure now given of the external force is only what is necessary for *balancing* the pressure of the water in the rising pipe. But in order that the pump may perform work, it must *surmount* this pressure, and cause the water to issue at D with such a velocity that the required quantity of water may be delivered in a given time. This requires force, even although here were no opposing pressure; which would be the case if the main were horizontal. The water fills it, but it is at rest. In order that a gallon, for instance, may be delivered in a second, the whole water in the horizontal main must be put in motion with a certain velocity. This requires force. We must therefore always distinguish between the state of equilibrium and the state of actual working. It is the equilibrium only that we consider at present; and no more is necessary for understanding the operation of the different species of pumps. The other force is of much more intricate investigation, and will be considered by itself.

Lifting pump.

The simplest form and situation of the lifting pump is represented by the sketch fig. 3. The pump is immersed in the cistern till both the valve G and piston F are under the surface AB of the surrounding water. By this means the water enters the pump, opening both valves, and finally stands on a level within and without.

Its mode of operation.

Now draw up the piston to the surface A. It must lift up the water which is above it (because the valve in the piston remains shut by its own weight); so that its surface will now be at *a*, A*a* being made equal to AF. In the mean time, the pressure of the surrounding water forces it into the working barrel, through the valve G; and the barrel is now filled with water. Now, let the piston be pushed down again; the valve G immediately shuts by its own weight, and in opposition to the endeavours which the water in the barrel makes to escape this way. This attempt to compress the water in the barrel causes it to open the valve F in the piston; or rather, this valve yields to our endeavour to push the piston down through the water in the working barrel. By this means we get the piston to the bottom of the barrel; and it has now above it the whole pillar of water reaching to the height *a*. Drawing up the piston to the surface A a second time, must lift this double column along with it, and its surface now will be at *b*. The piston may again be thrust down through the water in the barrel, and again drawn up to the surface; which will raise the water to *c*. Another repetition will raise it to *d*; and it will now show itself at the intended place of delivery. Another repetition will raise it to *e*; and while the piston is now descending to make another stroke, the water in *ed* will be running off through the spout D; and thus a stream will be produced, in some degree continual, but very unequal. This is inconvenient in many cases: thus, in a pump for domestic uses, such a hobbling stream would make it very troublesome to fill a bucket. It is therefore usual to terminate the main by a cistern LMNO, and to make the spout small. By this means the water brought up by the successive strokes of the piston rises to such a height in this cistern, as to produce an efflux by the spout nearly equable. The smaller we make the spout D the more equable will be the stream; for when the piston brings up more water than can be discharged during its descent, some of it remains in the cistern. This, added to the supply of next stroke, makes the water rise higher in the cistern than it did by the preceding stroke. This will cause the efflux to be quicker during the descent of the piston, but perhaps not yet sufficiently quick to discharge the whole supply. It therefore rises higher next stroke; and at last it rises so high, that the increased velocity of efflux makes the discharge precisely balance the supply. Now, the quantity supplied in each stroke is the same, and occupies the same room in the cistern at top; and the surface will sink the same number of inches during the descent of the piston, whether that surface has been high or low at the beginning. But because the velocities of the efflux are as the square roots of the heights of the water above the spout, it is evident that a sink of two or three inches will make a smaller change in the velocity of efflux when this height and velocity are great. This seems but a trifling observation; but it serves to illustrate a thing to be considered afterwards, which is important and abstruse, but perfectly similar to this.

It is evident, that the force neceſſary for this operation muſt be equal to the weight of the pillar of water $dAaD$, if the pipe be perpendicular. If the pump be ſtanding aſlope, the preſſure which is to be balanced is ſtill equal to the weight of a pillar of water of this perpendicular height, and having the ſurface of the piſton for its baſe.

Such is the ſimpleſt, and, we may add, by far the beſt, form of the forcing and lifting pumps; but it is not the moſt uſual. Circumſtances of convenience, economy, and more frequently of fancy and habit, have cauſed the pump-makers to deviate greatly from this form. It is not uſual to have the working barrel in the water; this, eſpecially in deep wells, makes it of difficult acceſs for repairs, and requires long piſton rods. This would not do in a forcing pump, becauſe they would bend.

7 ...ect of ...ing the ...ton a ...ger ...ke.

We have ſuppoſed, in our account of the lifting pump, that the riſe of the piſton always terminated at the ſurface of the water in the ciſtern. This we did in order that the barrel might always be filled by the preſſure of the ſurrounding water. But let us ſuppoſe that the riſe of the piſton does not end here, and that it is gradually drawn up to the very top: it is plain that the preſſure of the atmoſphere is by this means taken off from the water in the pipe (see PNEUMATICS), while it remains preſſing on the water of the ciſtern. It will therefore cauſe the water to follow the piſton as it riſes through the pipe, and it will raiſe it in this way 33 feet at a medium. If, therefore, the ſpout D is not more than 33 feet above the ſurface of the water in the ciſtern, the pipe will be full of water when the piſton is at D. Let it be puſhed down to the bottom; the water will remain in the pipe, becauſe the valve G will ſhut: and thus we may give the piſton a ſtroke of any length not exceeding 33 feet. If we raiſe it higher than this, the water will not follow; but it will remain in the pipe, to be lifted by the piſton, after it has been puſhed down through it to the bottom.

8 ...nveni- and un- ...ſſary.

But it is not neceſſary, and would be very inconvenient, to give the piſton ſo long a ſtroke. The great uſe of a pump is to render effectual the reciprocation of a ſhort ſtroke which we can command, while ſuch a long ſtroke is generally out of our power. Suppoſe that the piſton is puſhed down only to b; it will then have a column bf incumbent on it, and it will lift this column when again drawn up. And this operation may be repeated like the former, when the piſton was always under water; for the preſſure of the atmoſphere will always cauſe the water to follow the piſton to the height of 33 feet.

Nor is it neceſſary that the fixed valve G be placed at the lower orifice of the pipe, nor even under water. For, while things are in the ſtate now deſcribed, the piſton drawn up to f, and the whole pipe full of water; if we ſuppoſe another valve placed at b above the ſurface of the ciſtern, this valve can do no harm. Now let the piſton deſcend, both valves G and b will ſhut. G may now be removed, and the water will remain ſupported in the ſpace bG by the air; and now the alternate motions of the piſton will produce the ſame effect as before.

9 ...ct of weight ...e wa- ...nd ...ure of ...tmo- ...re.

We found in the former caſe that the piſton was carrying a load equal to the weight of a pillar of water of the height AD, becauſe the ſurrounding water could only ſupport it at its own level. Let us ſee what change is produced by the aſſiſtance of the preſſure of the atmoſphere. Let the under ſurface of the piſton be at b; when the piſton was at f, 33 feet above the ſurface of the ciſtern, the water was raiſed to that height by the preſſure of the atmoſphere. Suppoſe a partition made at b by a thin plate, and all the water above it taken away. Now pierce a hole in this plate. The preſſure of the atmoſphere was able to carry the whole column fa. Part of this column is now removed, and the remainder is not a balance for the air's preſſure. This will therefore cauſe the water to ſpout up through this hole and riſe to f. Therefore the under ſurface of this plate is preſſed up by the contiguous water with a force equal to the weight of that pillar of water which it formerly ſupported; that is, with a force equal to the weight of the pillar fb. Now, the under ſurface of the piſton, when at b, is in the ſame ſituation. It is preſſed upwards by the water below it, with a force equal to the weight of the column fb: But it is preſſed downwards by the whole preſſure of the atmoſphere, which preſſes on all bodies; that is, with the weight of the pillar fa. On the whole, therefore, it is preſſed downwards by a force equal to the difference of the weights of the pillars fa and fb; that is, by a force equal to the weight of the pillar ba.

It may be conceived better perhaps in this way. When the piſton was under the ſurface of the water in the ciſtern, it was equally preſſed on both ſides, both by the water and atmoſphere. The atmoſphere exerted its preſſure on it by the intervention of the water; which being, to all ſenſe, a perfect fluid, propagates every external preſſure undiminiſhed. When the piſton is drawn up above the ſurface of the pit-water, the atmoſphere continues to preſs on its upper ſurface with its whole weight, through the intervention of the water which lies above it; and its preſſure muſt therefore be added to that of the incumbent water. It alſo continues to preſs on the under ſurface of the piſton by the intervention of the water; that is, it preſſes this water to the piſton. But, in doing this, it carries the weight of this water which it is preſſing on the piſton. The preſſure on the piſton therefore is only the exceſs of the whole preſſure of the atmoſphere above the weight of the column of water which it is ſupporting. Therefore the difference of atmoſpheric preſſure on the upper and under ſurfaces of the piſton is preciſely equal to the weight of the column of water ſupported in the pipe by the air. It is not, however, the individual weight of this column that loads the piſton; it is the part of the preſſure of the atmoſphere on its upper ſurface, which is not balanced by its preſſure on the under ſurface.

In attempting therefore to draw up the piſton, we have to ſurmount this unbalanced part of the preſſure of the atmoſphere, and alſo the weight of the water which lies above the piſton, and muſt be lifted by it: and thus the whole oppoſing preſſure is the ſame as before, namely, the weight of the whole vertical pillar reaching from the ſurface of the water in the ciſtern to the place of delivery. Part of this weight is immediately carried by the preſſure of the atmoſphere; but, in lieu of it, there is an equal part of this preſſure of the atmoſphere abſtracted from the under ſurface of the piſton, while its upper ſurface ſuſtains its whole preſſure. 10

So far, then, theſe two ſtates of the pump agree.—But they differ exceedingly in their mode of operation; and there are ſome circumſtances not very obvious which muſt be attended to, in order that the pump may deli- Other circumſtances to be attended to.

 ver

Pump.

ver any water at the spout D. This requires, therefore, a serious examination.

Let the fixed valve G (fig. 4.) be supposed at the surface of the cistern water. Let M m be the lowest, and N n the highest, positions of the piston, and let $HA=h$ be the height of a column of water equiponderant with the atmosphere.

When the pump is filled, not with water, but with air, and the piston is in its lowest position, and all in equilibrio, the internal air has the same density and elasticity with the external. The space MA $a\,m$, therefore, contains air of the common density and elasticity. These may be measured by h, or the weight of a column of water whose height is h. Now, let the piston be drawn up to N n. The air which occupied the space MA $a\,m$ now occupies the space NA $a\,n$, and its density is now $\frac{\text{MA}\,a\,m}{\text{NA}\,a\,n}$. Its elasticity is now diminished, being proportionable to its density (see PNEUMATICS), and no longer balances the pressure of the atmosphere. The valve G will therefore be forced up by the water, which will rise to some height SA. Now let the piston again descend to M m. It cannot do this with its valve shut; for when it comes down so far as to reduce the air again to its common density, it is not yet at M, because the space below it has been diminished by the water which got into the pipe, and is retained there by the valve G. The piston valve, therefore, opens by the air which we thus attempt to compress, and the superfluous air escapes. When the piston has got to M, the air is again of the common density, and occupies the space MS $s\,m$. Now draw the piston up to N. This air will expand into the space NS $s\,n$, and its density will be reduced to $\frac{\text{MS}\,s\,m}{\text{NS}\,s\,n}$, and its elasticity will no longer balance the pressure of the atmosphere, and more water will enter, and it will rise higher. This will go on continually. But it may happen that the water will never rise so high as to reach the piston, even though not 33 feet above the water in the cistern: For the successive diminutions of density and elasticity are a series of quantities that decrease geometrically, and therefore will have a limit. Let us see what determines this limit.

At whatever height the water stands in the lower part of the pipe, the weight of the column of water SA $a\,s$, together with the remaining elasticity of the air above it, exactly balances the pressure of the atmosphere (see PNEUMATICS, n°108.) Now the elasticity of the air in the space NS $s\,n$ is equal to $h\times\frac{\text{MS}\,s\,m}{\text{NS}\,s\,n}$. Therefore, in the case where the limit obtains, and the water rises no farther, we must have $h=\text{AS}+h\,\frac{\text{MS}\,s\,m}{\text{NS}\,s\,n}$, or, because the column is of the same diameter throughout, $h=\text{AS}+h\frac{\text{MS}}{\text{NS}}$ and $\frac{\text{MS}}{\text{NS}}\,h=h-\text{AS},=\text{HS}$, and NS : MS $=$HA : HS, and NS$-$MS : NS$=$HA$-$HS : HA, or NM : NS$=$AS : AH, and NM$\times$AH$=$NS$\times$AS.— Therefore, if AN, the distance of the piston in its highest position from the water in the cistern, and NM the length of its stroke, be given, there is a certain determined height AS to which the water can be raised by the pressure of the air: For AH is a constant quantity; and therefore when MN is given, the rectangle AS$\times$SN is given. If this height AS be less than that of the piston in its lowest position, the pump will raise no water, although AN may be less than AH. Yet the same pump will raise water very effectually, if it be first of all filled with water; and we have seen professional engineers much puzzled by this capricious failure of their pumps. A little knowledge of the principles would have prevented their disappointment.

11 Mode of securing the delivery of water.

To insure the delivery of water by the pump, the stroke must be such that the rectangle MN$\times$AH may be greater than any rectangle that can be made of the parts of AN, that is, greater than the square of half AN. Or, if the length of the stroke be already fixed by other circumstances, which is a common case, we must make AN so short that the square of its half, measured in feet, shall be less than 33 times the stroke of the piston.

Suppose that the fixed valve, instead of being at the surface of the water in the cistern, is at S, or any where between S and A, the performance of the pump will be the same as before: But if it be placed anywhere above S, it will be very different. Let it be at T. It is plain that when the piston is pushed down from N to M, the valve at T prevents any air from getting down; and therefore, when the piston is drawn up again, the air contained in the space MT $t\,m$ will expand into the space NT $t\,n$, and its density will be $\frac{\text{MT}}{\text{NT}}$. This is less than $\frac{\text{MS}}{\text{NS}}$, which expresses the density of the air which was left in the space TS $s\,t$ by the former operations.— The air, therefore, in TS $s\,t$ will also expand, will open the valve, and now the water will rise above S. The proportion of NS to NT may evidently be such that the water will even get above the valve T. This diminishes the space NT $t\,n$; and therefore, when the piston has been pushed down to M, and again drawn up to N, the air will be still more rarefied, and the water will rise still higher. The foregoing reasoning, however, is sufficient to show that there may still be a height which the water will not pass, and that this height depends on the proportion between the stroke of the piston and its distance from the water in the cistern. We need not give the determination, because it will come in afterwards in combination with other circumstances. It is enough that the reader sees the physical causes of this limitation: And, lastly, we see plainly that the utmost security will be given for the performance of the pump, when the fixed valve is so placed that the piston, when in its lowest position, shall come into contact with it. In this case, the rarefaction of the air will be the completest possible; and, if there were no space left between the piston and valve, and all were perfectly air-tight, the rarefaction would be complete, and the valve might be any thing less than 33 feet from the surface of the water in the cistern. 12

12 Valves not easily kept air-tight.

But this perfect contact and tightness is unattainable; and though the pump may be full of water, its continual downward pressure causes it to filtrate slowly through every crevice, and the air enters through every pore, and even disengages itself from the water, with which a considerable portion had been chemically combined. The pump by this means loses water, and it requires several strokes of brisk working to fill it again: and

and if the leathers have become dry, fo much admiffion may be given to the air, that the pump will not fill itfelf with water by *any working*. It is then neceffary to pour water into it, which fhuts up thefe paffages, and foon fets all to rights again. For thefe reafons, it is always prudent to place the fixed valve as low as other circumftances will permit, and to make the pifton rod of fuch a length, that when it is at the bottom of its ftroke it fhall be almoft in contact with the valve. When we are not limited by other circumftances, it is evident that the beft poffible form is to have both the pifton and the fixed valve under the furface of the water of the ciftern. In this fituation they are always wet and air-tight. The chief objection is, that by this difpofition they are not eafily come at when needing repair. This is a material objection in deep mines. In fuch fituations, therefore, we muft make the beft compenfation of different circumftances that we can. It is ufual to place the fixed valve at a moderate diftance from the furface of the water, and to have a hole in the fide of the pipe, by which it may be got out. This is carefully fhut up by a plate firmly fcrewed on, with leather or cement between the parts. This is called the *clack door*. It would, in every cafe, be very proper to have a fixed valve in the lower end of the pipe. This would combine all advantages. Being always tight, the pipe would retain the water, and it would leave to the valve above it its full effect of increafing the rarefaction. A fimilar hole is made in the working barrel, a little above the higheft pofition of the pifton. When this needs repair, it can be got at through this hole, without the immenfe trouble of drawing up the whole rods.

Thus we have conducted the reader ftep by ftep, from the fimpleft form of the pump to that which long experience has at laft felected as the moft generally convenient. This we fhall now defcribe in fome detail.

13 [Descrip-tion of the Sucking-Pump.]

The Sucking Pump confifts of two pipes DCCD, BAAB (fig. 5.); of which the former is called the *Barrel*, or the *Working Barrel*, and the other is called the *Suction-pipe*, and is commonly of a fmaller diameter.—Thefe are joined by means of ftanches E, F, pierced with holes to receive fcrewed bolts. A ring of leather, or of lead, covered with a proper cement, is put between them; which, being ftrongly compreffed by the fcrew-bolts, renders the joint perfectly air-tight.—The lower end A of the fuction-pipe is commonly fpread out a little to facilitate the entry of the water, and frequently has a grating acrofs it at AA to keep out filth or gravel. This is immerged in the ftanding water YZ. The working barrel is cylindrical, as evenly and fmoothly bored as poffible, that the pifton may fill it exactly through its whole length, and move along it with as little friction as may be confiftent with air-tightnefs.

The pifton is a fort of truncated cone OPKL, generally made of wood not apt to fplit, fuch as elm or beech. The fmall end of it is cut off at the fides, fo as to form a fort of arch OQP, by which it is faftened to the iron rod or fpear. It is exhibited in different pofitions in figures 6, 7. which will give a more diftinct notion of it than any defcription. The two ends of the conical part may be hooped with brafs. This cone has its larger end furrounded with a ring or band of ftrong leather faftened with nails, or by a copper hoop, which is driven on it at the fmaller end. This band fhould reach to fome diftance beyond the bafe of the cone; the farther the better: and the whole muft be of uniform thicknefs all round, fo as to fuffer equal compreffion between the cone and the working barrel. The feam or joint of the two ends of this band muft be made very clofe, but not fewed or ftitched together. This would occafion bumps or inequalities, which would fpoil its tightnefs; and no harm can refult from the want of it, becaufe the two edges will be fqueezed clofe together by the compreffion in the barrel. It is by no means neceffary that this compreffion be great. This is a very detrimental error of the pump-makers. It occafions enormous friction, and deftroys the very purpofe which they have in view, viz. rendering the pifton air-tight; for it caufes the leather to wear through very foon at the edge of the cone, and it alfo wears the working barrel. This very foon becomes wide in that part which is continually paffed over by the pifton, while the mouth remains of its original diameter, and it becomes impoffible to thruft in a pifton which fhall completely fill the worn part. Now, a very moderate preffure is fufficient for rendering the pump perfectly tight, and a piece of glove leather would be fufficient for this purpofe, if loofe or detached from the folid cone; for fuppofe fuch a loofe and flexible, but impervious, band of leather put round the pifton, and put into the barrel; and let it even be fuppofed that the cone does not comprefs it in the fmalleft degree to its internal furface.—Pour a little water carefully into the infide of this fort of cup or difh; it will caufe it to fwell out a little, and apply itfelf clofe to the barrel all round, and even adjuft itfelf to all its inequalities. Let us fuppofe it to touch the barrel in a ring of an inch broad all round. We can eafily compute the force with which it is preffed. It is half the weight of a ring of water an inch deep and an inch broad. This is a trifle, and the friction occafioned by it not worth regarding; yet this trifling preffure is fufficient to make the paffage perfectly impervious, even by the moft enormous preffure of a high column of incumbent water: for let this preffure be ever fo great, the preffure by which the leather adheres to the barrel always exceeds it, becaufe the incumbent fluid has no *preponderating* power by which it can force its way between them, and it muft infinuate itfelf precifely fo far, that its preffure on the infide of the leather fhall ftill exceed, and only exceed, the preffure by which it endeavours to infinuate itfelf; and thus the pifton becomes perfectly tight with the fmalleft poffible friction. This reafoning is perhaps too refined for the uninftructed artift, and probably will not perfuade him. To fuch we would recommend an examination of the piftons and valves contrived and executed by that artift, whofe fkill far furpaffes our higheft conceptions, the all-wife Creator of this world. The valves which fhut up the paffages of the veins, and this in places where an extravafation would be followed by inftant death, are cups of thin membrane, which adhere to the fides of the channel about half way round, and are detached in the reft of their circumference. When the blood comes in the oppofite direction, it pufhes the membrane afide, and has a paffage perfectly free. But a ftagnation of motion allows the tone of the mufcular (perhaps) membrane, to reftore it to its natural fhape, and the leaft *motion* in the oppofite direction caufes it inftantly to clap clofe to the fides of the vein, and then no preffure whatever can force a paffage. We fhall recur to

[Pump.] 14 Neceffity of air tightnefs not properly attended to.

15 An eafy mode of rendering pumps tight.

16 Proved to be practicable from the human frame.

Pump.

to this again, when describing the various contrivances of valves, &c. What we have said is enough for supporting our directions for constructing a tight piston.

17 Best form of a piston recommended.

But we recommended thick and strong leather, while our present reasoning seems to render thin leather preferable. If the leather be thin, and the solid piston in any part does not press it gently to the barrel, there will be in this part an unbalanced pressure of the incumbent column of water, which would instantly burst even a strong leather bag; but when the solid piston, covered with leather, exactly fills the barrel, and is even pressed a little to it, there is no such risk; and now that part of the leather band which reaches beyond the solid piston performs its office in the completest manner. We do not hesitate, therefore, to recommend this form of a piston, which is the most common and simple of all, as preferable, when well executed, to any of those more artificial, and frequently very ingenious, constructions, which we have met with in the works of the first engineers. To proceed, then, with our description of the sucking-pump.

18 Further description of the sucking-pump.

At the joining of the working barrel with the suction pipe there is a hole H, covered with a valve opening upwards. This hole H is either made in a plate which makes a part of the suction-pipe, being cast along with it, or it is made in a separate plate. This last is the most convenient, being easily removed and replaced. Different views are given of this valve in fig. 8, 9, 10. The diameter EF (fig. 10.) of this plate is the same with that of the flanches, and it has holes corresponding to them, through which their bolts pass which keep all together. A ring of thick leather NKL is applied to this plate, having a part cut out between N and L, to make room for another piece of strong leather NR (fig. 9.) which composes the valve. The circular part of this valve is broader than the hole in the middle of fig. 10. but not quite so broad as to fill up the inside of the ring of leather OQP of this fig. which is the same with GKI of fig. 10. The middle of this leather valve is strengthened by two brass (not iron) plates, the uppermost of which is seen at R of fig. 9: the one on its underside is a little smaller than the hole in the valve-plate, that it may go freely in; and the upper plate R is larger than this hole, that it may compress the leather to its brim all round. It is evident, that when this plate with its leathers is put between the joint flanches, and all is screwed together, the tail of leather N of fig. 9. will be compressed between the plates, and form a hinge, on which the valve can turn, rising and falling. There is a similar valve fastened to the upper side, or broadest base of the piston. This description serves for both valves, and in general for most valves which are to be found in any parts of a pump.

19 Its mode of operation.

The reader will now understand, without any repetition, the process of the whole operation of a sucking-pump. The piston rarefies the air in the working barrel, and that in the suction-pipe expands thro' the valve into the barrel; and, being no longer a balance for the atmospheric pressure, the water rises into the suction-pipe; another stroke of the piston produces a similar effect, and the water rises farther, but by a smaller step than by the preceding stroke: by repeating the strokes of the piston, the water gets into the barrel; and when the piston is now pushed down through it, it gets above the piston, and must now be lifted up to any height. The suction-pipe is commonly of smaller size than the working barrel, for the sake of economy. It is not necessary that it be so wide: but it may be, and often is, made too small. It should be of such a size, that the pressure of the atmosphere may be able to fill the barrel with water as fast as the piston rises. If a void is left below the piston, it is evident that the piston must be carrying the whole weight of the atmosphere, besides the water which is lying above it. Nay, if the pipe be only so wide, that the barrel shall fill precisely as fast as the piston rises, it must sustain all this pressure. The suction-pipe should be wider than this, that all the pressure of the atmosphere which exceeds the weight of the pillar in the suction-pipe may be employed in pressing it on the under surface of the piston, and thus diminish the load. It cannot be made too wide; and too strict an economy in this respect may very sensibly diminish the performance of the pump, and more than defeat its own purpose. This is most likely when the suction-pipe is long, because there the length of the pillar of water nearly balances the air's pressure, and leaves very little accelerating force; so that water will rise but slowly even in the widest pipe. All these things will be made the subjects of computation afterwards.

It is plain that there will be limitations to the rise of the water in the suction-pipe, similar to what we found when the whole pump was an uniform cylinder. Let a be the height of the fixed valve above the water in the cistern: let B and b be the spaces in cubic measure between this valve and the piston in its highest and lowest positions, and therefore express the bulks of the air which may occupy these spaces: let y be the distance between the fixed valve and the water in the suction-pipe, when it has attained its greatest height by the rarefaction of the air above it: let h be the height of a column of water in equilibrio, with the whole pressure of the atmosphere, and therefore having its weight in equililibrio with the elasticity of common air: and let x be the height of the column whose weight balances the elasticity of the air in the suction-pipe, when rarefied as much as it can be by the action of the piston, the water standing at the height $a-y$.

Then, because this elasticity, together with the column $a-y$ in the suction-pipe, must balance the whole pressure of the atmosphere, (see PNEUMATICS, n° 108.), we must have $h = x + a - y$, and $y = a + x - h$.

When the piston was in its lowest position, the bulk of the air between it and the fixed valve was b. Suppose the valve kept shut, and the piston raised to its highest position, the bulk will be B, and its density $\frac{b}{B}$, and its elasticity, or the height of the column whose weight will balance it, will be $h\,\frac{b}{B}$. If the air in the suction-pipe be denser than this, and consequently more elastic, it will lift the valve, and some will come in; therefore, when the pump has rarefied the air as much as it can, so that none does, in fact, come in, the elasticity of the air in the suction-pipe *must* be the same. Therefore $x = h\,\frac{b}{B}$.

We

We had $y = a + x - h$. Therefore $y = a + b\frac{b}{B} - h, = a + \frac{b - B}{B}h, = a - \frac{B - b}{B}h$.

Therefore when $\frac{B - b}{B}h$ is less than a, the water will stop before it reaches the fixed valve. But when a is less than $\frac{B - b}{B}h$, the water will get above the fixed valve, y becoming negative.

But it does not follow that the water will reach the piston, that is, will rise so high that the piston will pass through it in its descent. Things now come into the condition of a pump of uniform dimensions from top to bottom; and this point will be determined by what was said when treating of such a pump.

20 There is another form of the sucking pump which is much used in great water works, and is of equal efficacy with the one now described. It is indeed the same pump in an inverted position. It is represented in fig. 11. where ABCD is the working barrel, immersed, with its mouth downwards, in the water of the cistern. It is joined by means of flanches to the rising pipe or MAIN.

This usually consists of two parts. The first, BEFC, is bent to one side, that it may give room for the iron frames TXYV, which carries the rod NO of the piston M, attached to the traverses RS, TOV of this frame. The other part, EGHF, is usually of a less diameter, and is continued to the place of delivery. The piston frame XTVY hangs by the rod Z, at the arm of a lever or working beam, not brought into the figure. The piston is perforated like the former, and is surrounded like it with a band of leather in form of a taper-dish. It has a valve K on its broad or upper base, opening when pressed from below. The upper end of the working barrel is pierced with a hole, covered with a valve I, also opening upwards.

Now suppose this apparatus immersed into the cistern till the water is above it, as marked by the line 2, 3, and the piston drawn up till it touch the end of the barrel. When the piston is allowed to descend by its own weight, the water rises up through its valve K, and fills the barrel. If the piston be now drawn up by the moving power of the machinery with which it is connected, the valve K shuts, and the piston pushes the water before it through the valve I into the main pipe EFGH. When the piston is again let down, the valve I shuts by its own weight and the pressure of the water incumbent on it, and the barrel is again filled by the water of the cistern. Drawing up the piston pushes this water into the main pipe, &c. and then the water is at length delivered at the place required.

21 This pump is usually called the *lifting pump*; perhaps the simplest of all in its principle and operation.— It needs no farther explanation: and we proceed to describe

22 The FORCING PUMP, represented in fig. 12. It consists of a working barrel ABCD, a suction-pipe CDEF, and a main or rising pipe. This last is usually in three joints. The first GHKI may be considered as making part of the working barrel, and is commonly cast in one piece with it. The second IKLM is joined to it by flanches, and forms the elbow which this pipe must generally have. The third LNOM is properly the beginning of the main, and is continued to the place of delivery. At the joint IK there is a hanging valve or clack S; and there is a valve R on the top of the suction-pipe.

The piston PQTV is solid, and is fastened to a stout iron rod which goes through it, and is fixed by a key drawn through its end. The body of the piston is a sort of double cone, widening from the middle to each end, and is covered with two bands of very strong leather, fitted to it in the manner already described. 23

The operation of this pump is abundantly simple. When the piston is thrust into the pump, it pushes the air before it through the valve S, for the valve R remains shut by its own weight. When it has reached near the bottom, and is drawn up again, the air which filled the small space between the piston and the valve S now expands into the barrel; for as soon as the air begins to expand, it ceases to balance the pressure of the atmosphere, which therefore shuts the valve S. By the expansion of the air in the barrel the equilibrium at the valve R is destroyed, and the air in the suction-pipe lifts the valve, and expands into the barrel; consequently it ceases to be a balance for the pressure of the atmosphere, and the water is forced into the suction-pipe. Pushing the piston down again forces the air in the barrel through the valve S, the valve R in the mean time shutting. When the piston is again drawn up, S shuts, R opens, the air in the suction-pipe dilates anew, and the water rises higher in it. Repeating these operations, the water gets at last into the working barrel, and is forced into the main by pushing down the piston, and is pushed along to the place of delivery. 24

The operation of this pump is therefore two-fold, sucking and forcing. In the first operation, the same force must be employed as in the sucking-pump, namely, a force equal to the weight of a column of water having the section of the piston for its base, and the height of the piston above the water in the cistern for its height. It is for the sake of this part of the operation that the upper cone is added to the piston. The air and water would pass by the sides of the lower cone while the piston is drawn up; but the leather of the upper cone applies to the surface of the barrel, and prevents this. The space contained between the barrel and the valve S is a great obstruction to this part of the operation, because this air cannot be rarefied to a very great degree. For this reason, the suction-pipe of a forcing-pump must not be made long. It is not indeed necessary; for by placing the pump a few feet lower, the water will rise into it without difficulty, and the labour of suction is as much diminished as that of impulsion is increased. However, an intelligent artist will always endeavour to make this space between the valve S and the lowest place of the piston as small as possible.

The power employed in forcing must evidently surmount the pressure of the whole water in the rising pipe, and (independent of what is necessary for giving the water the required velocity, so that the proper quantity per hour may be delivered), the piston has to withstand a force equal to the weight of a column of water having the section of the piston for its base, and the perpendicular altitude of the place of delivery above the lower surface of the piston for its height. It is quite

Pump.

quite indifferent in this refpect what is the diameter of the rifing pipe; becaufe the preffure on the pifton depends on the altitude of the water only, independent of its quantity. We fhall even fee that a fmall rifing pipe will require a greater force to convey the water along it to any given height or diftance.

When we would employ a pump to raife water in a crooked pipe, or in any pipe of moderate dimenfions, this form of pump, or fomething equivalent, muft be ufed. In bringing up great quantities of water from mines, the common fucking-pump is generally employed, as really the beft of them all: but it is the moft expenfive, becaufe it requires the pipe to be perpendicular, ftraight, and of great dimenfions, that it may contain the pifton rods. But this is impracticable when the pipe is crooked.

If the forcing pump, conftructed in the manner now defcribed, be employed, we cannot ufe forcers with long rods. Thefe would bend when pufhed down by their further extremity. In this cafe, it is ufual to employ only a fhort and ftiff rod, and to hang it by a chain, and load it with a weight fuperior to the weight of water to be raifed by it. The machinery therefore is employed, not in forcing the water along the rifing-pipe, but in raifing the weight which is to produce this effect by its fubfequent defcent.

In this cafe, it would be much better to employ the lifting-pump of fig. 11. For as the load on the forcers muft be greater than the refiftances which it muft furmount, the force exerted by the machine muft in like manner be greater than this load. This double excefs would be avoided by ufing the lifting-pump.

25
Meafure of the quantity of water delivered by any pump.

It will readily occur to the reader that the quantity of water delivered by any pump will be in the joint proportion of the furface or bafe of the pifton and its velocity: for this meafures the capacity of that part of the working barrel which the pifton paffes over. The velocity of the water in the conduit pipe, and in its paffage through every valve, will be greater or lefs than the velocity of the pifton in the fame proportion that the area of the pifton or working barrel is greater or lefs than the area of the conduit or valve. For whatever quantity of water paffes through any fection of the working-barrel in a fecond, the fame quantity muft go through any one of thefe paffages. This enables us to modify the velocity of the water as we pleafe: we can increafe it to any degree at the place of delivery by diminifhing the aperture through which it paffes, provided we apply fufficient force to the pifton.

26
The operation of pumps not equable;

It is evident that the operation of a pump is by ftarts, and that the water in the main remains at reft, preffing on the valve during the time that the pifton is withdrawn from the bottom of the working barrel. It is in moft cafes defirable to have this motion equable, and in fome cafes it is abfolutely neceffary. Thus, in the engine for extinguifhing fires, the fpout of water going by jerks could never be directed with a certain aim, and half of the water would be loft by the way; becaufe a body at reft cannot in an inftant be put in rapid motion, and the firft portion of every jerk of water would have but a fmall velocity. A very ingenious contrivance has been fallen upon for obviating this inconvenience, and procuring a ftream nearly equable.

27
And the mode of making them fo.

We have not been able to difcover the author. At any convenient part of the rifing pipe beyond the valve S there is annexed a capacious veffel VZ (fig. 13. n° 1 and 2.) clofe atop, and of great ftrength. When the water is forced along this pipe, part of it gets into this veffel, keeping the air confined above it, and it fills it to fuch a height V, that the elafticity of the confined air balances a column reaching to T, we fhall fuppofe, in the rifing pipe. The next ftroke of the pifton fends forward more water, which would fill the rifing pipe to fome height above T. But the preffure of this additional column caufes fome more of it to go into the air veffel, and comprefs its air fo much more that its elafticity now balances a longer column. Every fucceeding ftroke of the pifton produces a like effect. The water rifes higher in the main pipe, but fome more of it goes into the air-veffel. At laft the water *appears* at the place of delivery; and the air in the air-veffel is now fo much compreffed that its elafticity balances the preffure of the whole column. The next ftroke of the pifton fends forward fome more water. If the diameter of the orifice of the main be fufficient to let the water flow out with a velocity equal to that of the pifton, it will fo flow out, rifing no higher, and producing no fenfible addition to the compreffion in the air-veffel. But if the orifice of the main be contracted to half its dimenfions, the water fent forward by the pifton cannot flow out in the time of the ftroke without a greater velocity, and therefore a greater force. Part of it, therefore, goes into the air-veffel, and increafes the compreffion. When the pifton has ended its ftroke, and no more water comes forward, the compreffion of the air in the air-veffel being greater than what was fufficient to balance the preffure of the water in the main pipe, now forces out fome of the water which is lying below it. This cannot return towards the pump, becaufe the valve S is now fhut. It therefore goes forward along the main, and produces an efflux during the time of the pifton's rifing in order to make another ftroke. In order that this efflux may be very equable, the air-veffel muft be very large. If it be fmall, the quantity of water that is difcharged by it during the return of the pifton makes fo great a portion of its capacity, that the elafticity of the confined air is too much diminifhed by this enlargement of its bulk, and the rate of efflux muft diminifh accordingly. The capacity of the air-veffel fhould be fo great that the change of bulk of the compreffed air during the inaction of the pifton may be inconfiderable. It muft therefore be very ftrong.

It is pretty indifferent in what way this air-veffel is connected with the rifing pipe. It may join it laterally, as in fig. 13. n° 1. and the main pipe go on without interruption; or it may be made to *furround* an interruption of the main pipe, as in fig. 13. n° 2. It may alfo be in any part of the main-pipe. If the fole effect intended by it is to produce an equable jet, as in ornamental water-works, it may be near the end of the main. This will require much lefs ftrength, becaufe there remains but a fhort column of water to comprefs the air in it. But it is, on the whole, more advantageous to place it as near the pump as poffible, that it may produce an equable motion in the whole main-pipe. This is of confiderable advantage; when a column of water feveral hundred feet long is at reft in the main-pipe, and the pifton at one end of it put at once into motion,

even

even with a moderate velocity, the ſtrain on the pipe would be very great. Indeed if it were poſſible to put the piſton inſtantaneouſly into motion with a finite velocity, the ſtrain on the pipe, tending to burſt it, would be next to infinite. But this ſeems impoſſible in nature; all changes of motion *which we obſerve* are gradual, becauſe all impelling bodies have ſome elaſticity or ſoftneſs by which they yield to compreſſion. And, in the way in which piſtons are commonly moved, *viz.* by cranks, or ſomething analogous to them, the motion is *very ſenſibly* gradual. But ſtill the air-veſſel tends to make the motion along the main-pipe leſs deſultory, and therefore diminiſhes thoſe ſtrains which would really take place in the main-pipe. It acts like the ſprings of a travelling carriage, whoſe jolts are incomparably leſs than thoſe of a cart; and by this means really enables a given force to propel a greater quantity of water in the ſame time.

We may here by the way obſerve, that the attempts of mechanicians to correct this unequal motion of the piſton-rod are miſplaced, and if it could be done, would greatly hurt a pump. One of the beſt methods of producing this effect is to make the piſton-rod conſiſt of two parallel bars, having teeth in the ſides which front each other. Let a toothed wheel be placed between them, having only the half of its circumference furniſhed with teeth. It is evident, without any farther deſcription, that if this wheel be turned uniformly round its axis, the piſton-rod will be moved uniformly up and down without intermiſſion. This has often been put in practice; but the machine always went by jolts, and ſeldom laſted a few days. Unſkilled mechanicians attributed this to defect in the execution: but the fault is eſſential, and lies in the principle.

The machine could not perform one ſtroke, if the firſt mover did not ſlacken a little, or the different parts of the machine did not yield by bending or by compreſſion; and no ſtrength of materials could withſtand the violence of the ſtrains at every reciprocation of the motion. This is chiefly experienced in great works which are put in motion by a water-wheel, or ſome other equal power exerted on the maſs of matter of which the machine conſiſts. The water-wheel being of great weight, moves with conſiderable ſteadineſs or uniformity; and when an additional reſiſtance is oppoſed to it by the beginning of a new ſtroke of the piſton, its great quantity of motion is but little affected by this addition, and it proceeds very little retarded; and the machine muſt either yield a little by bending and compreſſion, or go to pieces, which is the common event. Cranks are free from this inconvenience, becauſe they accelerate the piſton gradually, and bring it gradually to reſt, while the water-wheel moves round with almoſt perfect uniformity. The only inconvenience (and it may be conſiderable) attending this ſlow motion of the piſton at the beginning of its ſtroke is, that the valves do not ſhut with rapidity, ſo that ſome water gets back through them. But when they are properly formed and loaded, this is but trifling.

31 We muſt not imagine, that becauſe the ſtream produced by the aſſiſtance of an air-barrel is almoſt perfectly equable, and becauſe as much water runs out during the returning of the piſton as during its active ſtroke, it therefore doubles the quantity of water. No more water can run out than what is ſent forward by the piſton during its effective ſtroke. The continued ſtream is produced only by preventing the whole of this water from being diſcharged during this time, and by providing a propelling force to act during the piſton's return. Nor does it enable the moving force of the piſton to produce a double effect: for the compreſſion which is produced in the air-veſſel, more than what is neceſſary for merely balancing the quieſcent column of water, reacts on the piſton, reſiſting its compreſſion juſt as much as the column of water would do which produces a velocity equal to that of the efflux. Thus if the water is made to ſpout with the velocity of eight feet per ſecond, this would require an additional column of one foot high, and this would juſt balance the compreſſion in the air-veſſel, which maintains this velocity during the non-action of the piſton. It is, however, a matter of fact, that a pump furniſhed with an air-veſſel delivers a little more water than it would do without it. But the difference depends on the combination of many very diſſimilar circumſtances, which it is extremely difficult to bring into calculation. Some of theſe will be mentioned afterwards.

To deſcribe, or even to enumerate, the immenſe variety of combinations of theſe three ſimple pumps would fill a volume. We ſhall ſelect a few, which are more deſerving of notice.

32 The ſucking pump converted into a lifting pump.

I. The common ſucking-pump may, by a ſmall addition, be converted into a lifting-pump, fitted for propelling the water to any diſtance, and with any velocity.

Fig. 14. is a ſucking-pump, whoſe working-barrel ACDB has a lateral pipe AEGHF connected with it cloſe to the top. This terminates in a *main* or riſing pipe IK, furniſhed or not with a valve L. The top of the barrel is ſhut up by a ſtrong plate MN, having a hollow neck terminating in a ſmall flanch. The piſton rod QR paſſes through this neck, and is nicely turned and poliſhed. A number of rings of leather are put over the rod, and ſtrongly compreſſed round it by another flanch and ſeveral ſcrewed bolts, as is repreſented at OP. By this contrivance the rod is cloſely graſped by the leathers, but may be eaſily drawn up and down, while all paſſage of air or water is effectually prevented.

The piſton S is perforated, and furniſhed with a valve opening upwards. There is alſo a valve T on the top of the ſuction-pipe YX; and it will be of advantage, though not abſolutely neceſſary, to put a valve L at the bottom of the riſing pipe. Now ſuppoſe the piſton at the bottom of the working-barrel. When it is drawn up, it tends to compreſs the air above it, becauſe the valve in the piſton remains ſhut by its own weight. The air therefore is driven through the valve L into the riſing pipe, and eſcapes. In the mean time, the air which occupied the ſmall ſpace between the piſton and the valve T expands into the upper part of the working barrel; and its elaſticity is ſo much diminiſhed thereby, that the atmoſphere preſſes the water of the ciſtern into the ſuction-pipe, where it will riſe till an equilibrium is again produced. The next downward ſtroke of the piſton allows the air, which had come from the ſuction-pipe into the barrel during the aſcent of the piſton, to get through its valve. Upon drawing up the piſton, this air is alſo drawn off through the riſing pipe. Repeating this proceſs brings the water

Pump.

ter at last into the working-barrel, and it is then driven along the rising-pipe by the piston.

33 Advantages of this conversion.

This is one of the best forms of a pump. The rarefaction may be very perfect, because the piston can be brought so near to the bottom of the working-barrel: and, for forcing water in opposition to great pressures, it appears preferable to the common forcing-pump; because in that the piston rods are compressed and exposed to bending, which greatly hurts the pump by wearing the piston and barrel on one side. This soon renders it less tight, and much water squirts out by the sides of the piston. But in this pump the piston rod is always drawn or pulled, which keeps it straight; and rods exert a much greater force in opposition to a pull than in opposition to compression. The collar of leather round the piston-rods is found by experience to need very little repairs, and is very impervious to water. The whole is very accessible for repairs; and in this respect much preferable to the common pump in deep mines, where every fault of the piston obliges us to draw up some hundred feet of piston-rods. By this addition, too, any common pump for the service of a house is converted into an engine for extinguishing fire, or may be made to convey the water to every part of the house; and this without hurting or obstructing its common uses. All that is necessary is to have a large cock on the upper part of the working barrel opposite to the lateral pipe in this figure. This cock serves for a spout when the pump is used for common purposes; and the merely shutting this cock converts the whole into an engine for extinguishing fire or for supplying distant places with water. It is scarcely necessary to add, that for these services it will be proper to connect an air-vessel with some convenient part of the rising pipe, in order that the current of the water may be continual.

34 Equable streams produced in great works by combinations.

We have frequently spoken of the advantages of a continued current in the main pipe. In all great works a considerable degree of uniformity is produced by the manner of disposing the actions of the different pumps; for it is very rarely that a machine works but one pump. In order to maintain some uniformity in the resistance, that it may not all be opposed at once to the moving power, with intervals of total inaction, which would produce a very hobbling motion, it is usual to distribute the work into portions, which succeed alternately; and thus both diminish the strain, and give greater uniformity of action, and frequently enable a natural power which we can command, to perform a piece of work, which would be impossible if the whole resistance were opposed at once. In all pump machines therefore we are obviously directed to construct them so that they may give motion to at least two pumps, which work alternately. By this means a much greater uniformity of current is produced in the main pipe. It will be rendered still more uniform if four are employed, succeeding each other at the interval of one quarter of the time of a complete stroke.

35 A single pump for this purpose described.

But ingenious men have attempted the same thing with a single pump, and many different constructions for this purpose have been proposed and executed. The thing is not of much importance, nor of great research. We shall content ourselves therefore with the description of one that appears to us the most perfect, both in respect of simplicity and effect.

II. It consists of a working-barrel AB (fig. 15.) close at both ends. The piston C is solid, and the rod OP passes through a collar of leathers in the plate, which closes the upper end of the working-barrel. This barrel communicates laterally with two pipes H, K; the communications *m* and *n* being as near to the top and bottom of the barrel as possible. Adjoining to the passage *m* are two valves F and G opening upwards. Similar valves accompany the passage *n*. The two pipes H and K unite in a larger rising pipe L. They are all represented as in the same plane; but the upper ends must be bent backwards, to give room for the motion of the piston-rod OP.

Suppose the piston close to the entry of the lateral pipe *n*, and that it is drawn up: it compresses the air above it, and drives it through the valve G, where it escapes along the rising pipe; at the same time it rarefies the air in the space below it. Therefore the weight of the atmosphere shuts the valve E, and causes the water of the cistern to rise through the valve D, and fill the lower part of the pump. When the piston is pushed down again, this water is first driven through the valve E, because D immediately shuts; and then most of the air which was in this part of the pump at the beginning goes up through it, some of the water coming back in its stead. In the mean time, the air which remained in the upper part of the pump after the ascent of the piston is rarefied by its descent; because the valve G shuts as soon as the piston begins to descend, the valve F opens, the air in this suction pipe F*f* expands into the barrel, and the water rises into the pipes by the pressure of the atmosphere. The next rise of the piston must bring more water into the lower part of the barrel, and must drive a little more air through the valve G, namely, part of that which had come out of the suction-pipe F*f*; and the next descent of the piston must drive more water into the rising pipe H, and along with it most if not all of the air which remained below the piston, and must rarefy still more the air remaining above the piston; and more water will come in through the pipe F*f*, and get into the barrel. It is evident that a few repetitions will at last fill the barrel on both sides of the piston with water. When this is accomplished, there is no difficulty in perceiving how, at every rise of the piston, the water of the cistern will come in by the valve D, and the water in the upper part of the barrel will be driven thro' the valve G; and, in every descent of the piston, the water of the cistern will come into the barrel by the valve F, and the water below the piston will be driven through the valve E: and thus there will be a continual influx into the barrel through the valves D and F, and a continual discharge along the rising pipe L through the valves E and G.

36 It is equivalent to two forcing pumps.

This machine is, to be sure, equivalent to two forcing pumps, although it has but one barrel and one piston; but it has no sort of superiority. It is not even more economical in most cases; because we apprehend that the additional workmanship will fully compensate for the barrel and piston that is saved. There is indeed a saving in the rest of the machinery, because one lever produces both motions. We cannot therefore say that it is inferior to two pumps; and we acknowledge that there is some ingenuity in the contrivance.

We recommend to our readers the perusal of Beli-

 dor's

dor's *Architecture Hydraulique*, where is to be found a great variety of combinations and forms of the simple pumps; but we must caution them with respect to his theories, which in this article are extremely defective. Also in Leupold's *Theatrum Machinarum Hydraulicarum*, there is a prodigious variety of all kinds of pumps, many of them very singular and ingenious, and many which have particular advantages, which may suit local circumstances, and give them a preference. But it would be improper to swell a work of this kind with so many peculiarities; and a person who makes himself master of the principles delivered here in sufficient detail, can be at no loss to suit a pump to his particular views, or to judge of the merit of such as may be proposed to him.

We must now take notice of some very considerable and important varieties in the form and contrivance of the essential parts of a pump.

38 III. The forcing pump is sometimes of a very different form from that already described. Instead of a piston, which applies itself to the inside of the barrel, and slides up and down in it, there is a long cylinder POQ (fig. 16.) nicely turned and polished on the outside, and of a diameter somewhat less than the inside of the barrel. This cylinder (called a PLUNGER) slides through a collar of leathers on the top of the working-barrel, and is constructed as follows. The top of the barrel terminates in a flanch *a b*, pierced with four holes for receiving screw-bolts. There are two rings of metal, *c d*, *e f*, of the same diameter, and having holes corresponding to those in the flanch. Four rings of soft leather, of the same size, and similarly pierced with holes, are well soaked in a mixture of oil, tallow, and a little rosin. Two of these leather rings are laid on the pump flanch, and one of the metal rings above them. The plunger is then thrust down through them, by which it turns their inner edges downwards. The other two rings are then slipped on at the top of the plunger, and the second metal ring is put over them, and then the whole are slid down to the metal ring. By this the inner edges of the last leather rings are turned upwards. The three metal rings are now forced together by the screwed bolts; and thus the leathern rings are strongly compressed between them, and made to grasp the plunger so closely that no pressure can force the water through between. The upper metal ring just allows the plunger to pass through it, but without any play; so that the turned up edges of the leathern rings do not come up between the plunger and the upper metal ring, but are lodged in a little conical taper, which is given to the inner edge of the upper plate, its hole being wider below than above. It is on this trifling circumstance that the great tightness of the collar depends. To prevent the leathers from shrinking by drought, there is usually a little cistern formed round the head of the pump, and kept full of water. The plunger is either forced down by a rod from a working beam, or by a set of metal-weights laid on it, as is represented in the figure.

39 It is hardly necessary to be particular in explaining the operation of this pump. When the plunger is at the bottom of the barrel, touching the fixed valve M with its lower extremity, it almost completely fills it. That it may do it completely, there is sometimes a small pipe RSZ branching out from the top of the barrel, and fitted with a cock at S. Water is admitted till the barrel is completely filled, and the cock is then shut. Now when the plunger is drawn up, the valve N in the rising pipe must remain shut by the pressure of the atmosphere, and a void must be made in the barrel. Therefore the valve M on the top of the suction-pipe must be opened by the elasticity of the air in this pipe, and the air must expand into the barrel; and, being no longer a balance for the atmosphere, the water in the cistern must be forced into the suction-pipe, and rise in it to a certain height. When the plunger descends, it must drive the water through the valve N (for the valve M will immediately shut), and along with it most of the air which had come into the barrel. And as this air occupied the upper part of the barrel, part of it will remain when the plunger has reached the bottom; but a stroke or two will expel it all, and then every succeeding stroke of the descending piston will drive the water along the rising pipe, and every ascent of the plunger will be followed by the water from the cistern.

The advantage proposed by this form of piston is, that it may be more accurately made and polished than the inside of a working barrel, and it is of much easier repair. Yet we do not find that it is much used, although an invention of last century (we think by Sir Samuel Morland), and much praised by the writers on these subjects.

It is easy to see that the sucking-pump may be varied in the same way. Suppose this plunger to be open both at top and bottom, but the bottom filled with a valve opening upward. When this is pushed to the bottom of the barrel, the air which it tends to compress lifts the valve (the lateral pipe FIK being taken away and the passage shut up), and escapes through the plunger. When it is drawn up, it makes the same rarefaction as the solid plunger, because the valve at O shuts, and the water will come up from the cistern as in the former case. If the plunger be now thrust down again, the valve M shuts, the valve O is forced open, and the plunger is filled with water. This will be lifted by it during its next ascent; and when it is pushed down again, the water which filled it must now be pushed out, and will flow over its sides into the cistern at the head of the barrel. Instead of making the valve at the bottom of the piston, it may be made at the top; but this disposition is much inferior, because it cannot rarefy the air in the barrel one half. This is evident; for the capacity of the barrel and plunger together cannot be twice the capacity of the barrel. 40

IV. It may be made after a still different form, as represented in fig. 17. Here the suction-pipe CO comes up through a cistern KMNL deeper or longer than the intended stroke of the piston, and has a valve C at top. The piston, or what acts in lieu of it, is a tube AHGB, open at both ends, and of a diameter somewhat larger than that of the suction-pipe. The interval between them is filled up at HG by a ring or belt of soft leather, which is fastened to the *outer* tube, and moves up and down with it, sliding along the smoothly polished surface of the suction-pipe with very little friction. There is a valve I on the top of this piston, opening upwards. Water is poured into the outer cistern. 41

The outer cylinder or piston being drawn up from the bottom, there is a great rarefaction of the air which 42

 was

was between them, and the atmosphere presses the water up through the suction-pipe to a certain height; for the valve I keeps shut by the pressure of the atmosphere and its own weight. Pushing down the piston causes the air, which had expanded from the suction-pipe into the piston, to escape through the valve I; drawing it up a second time, allows the atmosphere to press more water into the suction-pipe, to fill it, and also part of the piston. When this is pushed down again, the water which had come through the valve C is now forced out through the valve I into the cistern KMNL, and now the whole is full of water. When, therefore, the piston is drawn up, the water follows, and fills it, if not 33 feet above the water in the cistern; and when it is pushed down again, the water which filled the piston is all thrown out into the cistern; and after this it delivers its full contents of water every stroke. The water in the cistern KMNL effectually prevents the entry of any air between the two pipes; so that a very moderate compression of the belt of soft leather at the mouth of the piston cylinder is sufficient to make all perfectly tight.

43 **The piston cylinder differently formed.**

It might be made differently. The ring of leather might be fastened round the top of the inner cylinder at DE, and slide on the inside of the piston cylinder; but the first form is most easily executed. Muschenbroeck has given a figure of this pump in his large system of natural philosophy, and speaks very highly of its performance. But we do not see any advantage which it possesses over the common sucking-pump. He indeed says that it is without friction, and makes no mention of the ring of leather between the two cylinders. Such a pump will raise water extremely well to a small height, and it seems to have been a model only which he had examined. But if the suction-pipe is long, it will by no means do without the leather; for on drawing up the piston, the water of the upper cistern will rise between the pipes, and fill the piston, and none will come up through the suction-pipe.

44 **Pumps without friction not of important use.**

We may take this opportunity of observing, that the many ingenious contrivances of pumps without friction are of little importance in great works; because the friction which is completely sufficient to prevent all escape of water in a well-constructed pump is but a very trifling part of the whole force. In the great pumps which are used in mines, and are worked by a steam-engine, it is very usual to make the pistons and valves without any leather whatever. The working barrel is bored truly cylindrical, and the piston is made of metal of a size that will just pass along it without sticking. When this is drawn up with the velocity competent to a properly loaded machine, the quantity of water which escapes round the piston is insignificant. The piston is made without leathers, not to avoid friction, which is also insignificant in such works; but to avoid the necessity of frequently drawing it up for repairs through such a length of pipes.

45 **Example of a simple pump without friction.**

V. If a pump absolutely without friction is wanted, the following seems preferable for simplicity and performance to any we have seen, when made use of in proper situations. Let NO (fig. 18.) be the surface of the water in the pit, and K the place of delivery. The pit must be as deep in water as from K to NO. ABCD is a wooden trunk, round or square, open at both ends, and having a valve P at the bottom. The top of this trunk must be on a level with K, and has a small cistern EADF. It also communicates laterally with a rising pipe GHK, furnished with a valve at H opening upwards. LM is a beam of timber so fitted to the trunk as to fill it without sticking, and is of at least equal length. It hangs by a chain from a working beam, and is loaded on the top with weights exceeding that of the column of water which it displaces. Now suppose this beam allowed to descend from the position in which it is drawn in the figure; the water must rise all around it, in the crevice which is between it and the trunk, and also in the rising pipe; because the valve P shuts, and H opens; so that when the plunger has got to the bottom, the water will stand at the level of K. When the plunger is again drawn up to the top by the action of the moving power, the water sinks again in the trunk, but not in the rising pipe, because it is stopped by the valve H. Then allowing the plunger to descend again, the water must again rise in the trunk to the level of K, and it must now flow out at K; and the quantity discharged will be equal to the part of the beam below the surface of the pit-water, deducting the quantity which fills the small space between the beam and the trunk. This quantity may be reduced almost to nothing; for if the inside of the trunk and the outside of the beam be made tapering, the beam may be let down till they exactly fit; and as this may be done in square work, a good workman can make it exceedingly accurate. But in this case, the lower half of the beam and trunk must not taper; and this part of the trunk must be of sufficient width round the beam to allow free passage into the rising pipe. Or, which is better, the rising pipe must branch off from the bottom of the trunk. A discharge may be made from the cistern EADF, so that as little water as possible may descend along the trunk when the piston is raised.

46 **Its excellencies considerable,**

One great excellence of this pump is, that it is perfectly free from all the deficiencies which in common pumps result from want of being air-tight. Another is, that the quantity of water raised is precisely equal to the power expended; for any want of accuracy in the work, while it occasions a diminution of the quantity of water discharged, makes an equal diminution in the weight which is necessary for pushing down the plunger. We have seen a machine consisting of two such pumps suspended from the arms of a long beam, the upper side of which was formed into a walk with a rail on each side. A man stood on one end till it got to the bottom, and then walked soberly up to the other end, the inclination being about twenty-five degrees at first, but gradually diminished as he went along, and changed the load of the beam. By this means he made the other end go to the bottom, and so on alternately, with the easiest of all exertions, and what we are most fitted for by our structure. With this machine, a very feeble old man, weighing 110 pounds, raised 7 cubic feet of water $11\frac{1}{2}$ feet high in a minute, and continued working 8 or 10 hours every day. A stout young man, weighing nearly 135 pounds, raised $8\frac{1}{7}$ to the same height; and when he carried 30 pounds, conveniently slung about him, he raised $9\frac{3}{4}$ feet to this height, working 10 hours a-day without fatiguing himself. This exceeds Desagulier's maximum of a hogshead of water 10 feet high in a minute, in the pro-

portion

portion of 9 to 7 nearly. It is limited to very moderate heights; but in ſuch ſituations it is very effectual. It was the contrivance of an untaught labouring man, poſſeſſed of uncommon mechanical genius. We ſhall have occaſion to mention, with reſpect, ſome other contrivances of the ſame perſon in the article *Water-Works*.

VI. The moſt ingenious contrivance of a pump without friction is that of Mr Haſkins, deſcribed by Deſaguliers, and called by him the Quicksilver Pump. Its conſtruction and mode of operation are pretty complicated; but the following preliminary obſervations will, we hope, render it abundantly plain.

Let *ilmk* (fig. 19.) be a cylindrical iron pipe, about ſix feet long, open at top. Let *eghf* be another cylinder, connected with it at the bottom, and of ſmaller diameter. It may either be ſolid, or, if hollow, it muſt be cloſe at top. Let *acdb* be a third iron cylinder, of an intermediate diameter, ſo that it may move up and down between the other two without touching either, but with as little interval as poſſible. Let this middle cylinder communicate by means of the pipe AB, with the upright pipe FE, having valves C and D (both opening upwards) adjoining to the pipe of communication. Suppoſe the outer cylinder ſuſpended by chains from the end of a working beam, and let mercury be poured into the interval between the three cylinders till it fills the ſpace to *op*, about $\frac{1}{2}$ of their height. Alſo ſuppoſe that the lower end of the pipe FE is immerſed into a ciſtern of water, and that the valve D is leſs than 33 feet above the ſurface of this water.

Now ſuppoſe a perforation made ſomewhere in the pipe AB, and a communication made with an air-pump. When the air-pump is worked, the air contained in CE, in AB, and in the ſpace between the inner and middle cylinders, is rarefied, and is abſtracted by the air-pump; for the valve D immediately ſhuts. The preſſure of the atmoſphere will cauſe the water to riſe in the pipe CE, and will cauſe the mercury to riſe between the inner and middle cylinders, and ſink between the outer and middle cylinders. Let us ſuppoſe mercury 12 times heavier than water: Then for every foot that the water riſes in EC, the level between the outſide and inſide mercury will vary an inch; and if we ſuppoſe DE to be 30 feet, then if we can rarefy the air ſo as to raiſe the water to D, the outſide mercury will be depreſſed to *q*, *r*, and the inſide mercury will have riſen to *s*, *t*, *sq* and *tr* being about 30 inches. In this ſtate of things, the water will run over by the pipe BA, and every thing will remain nearly in this poſition. The columns of water and mercury balance each other, and balance the preſſure of the atmoſphere.

While things are in this ſtate of equilibrium, if we allow the cylinders to deſcend a little, the water will riſe in the pipe FE, which we may now conſider as a ſuction-pipe; for by this motion the capacity of the whole is enlarged, and therefore the preſſure of the atmoſphere will ſtill keep it full, and the ſituation of the mercury will again be ſuch that all ſhall be in equilibrio. It will be a little lower in the inſide ſpace and higher in the outſide.

Taking this view of things, we ſee clearly how the water is ſupported by the atmoſphere at a very conſiderable height. The apparatus is analogous to a ſyphon which has one leg filled with water and the other with mercury. But it was not neceſſary to employ an air-pump to fill it. Suppoſe it again empty, and all the valves ſhut by their own weight. Let the cylinders deſcend a little. The capacity of the ſpaces below the valve D is enlarged, and therefore the included air is rarefied, and ſome of the air in the pipe CE muſt diffuſe itſelf into the ſpace quitted by the inner cylinder. Therefore the atmoſphere will preſs ſome water up the pipe FE, and ſome mercury into the inner ſpace between the cylinders. When the cylinders are raiſed again, the air which came from the pipe CE would return into it again, but is prevented by the valve C.—Raiſing the cylinders to their former height would compreſs this air; it therefore lifts the valve D, and eſcapes. Another depreſſion of the cylinders will have a ſimilar effect. The water will riſe higher in FC, and the mercury in the inner ſpace; and then, after repeated ſtrokes, the water will paſs the valve C, and fill the whole apparatus, as the air-pump had cauſed it to do before.—The poſition of the cylinders, when things are in this ſituation, is repreſented in fig. 20, the outer and inner cylinders in their loweſt poſition having deſcended about 30 inches. The mercury in the outer ſpace ſtands at *q*, *r*, a little above the middle of the cylinders, and the mercury in the inner ſpace is near the top *ts* of the inner cylinder. Now let the cylinders be drawn up. The water above the mercury cannot get back again through the valve C, which ſhuts by its own weight. We therefore attempt to compreſs it; but the mercury yields, and deſcends in the inner ſpace, and riſes in the outer till both are quickly on a level, about the height *vv*. If we continue to raiſe the cylinders, the compreſſion forces out more mercury, and it now ſtands lower in the inner than in the outer ſpace. But that there may be ſomething to balance this inequality of the mercurial columns, the water goes through the valve D, and the equilibrium is reſtored when the height of the water in the pipe ED above the ſurface of the internal mercury is 12 times the difference of the mercurial columns (on the former ſuppoſition of ſpecific gravity.) If the quantity of water is ſuch as to riſe two feet in the pipe ED, the mercury in the outer ſpace will be two inches higher than that in the inner ſpace. Another depreſſion of the cylinders will again enlarge the ſpace within the apparatus, the mercury will take the poſition of fig. 19. and more water will come in. Raiſing the cylinders will ſend this water four feet up the pipe ED, and the mercury will be four inches higher in the inner than in the outer ſpace. Repeating this operation, the water will be raiſed ſtill higher in DE; and this will go on till the mercury in the outer ſpace reaches the top of the cylinder; and this is the limit of the performance. The dimenſions with which we ſet out will enable the machine to raiſe the water about 30 feet in the pipe ED; which, added to the 30 feet of CF, makes the whole height above the pit-water 60 feet. By making the cylinders longer, we increaſe the height of FD. This machine muſt be worked with great attention, and but ſlowly; for at the beginning of the forcing ſtroke the mercury very rapidly ſinks in the inner ſpace and riſes in the outer, and will daſh out and be loſt. To pre-

vent this as much as poſſible, the outer cylinder terminates in a ſort of cup or diſh, and the inner cylinder ſhould be tapered atop.

50
Ingenuity of the contrivance great,

The machine is exceedingly ingenious and refined; and there is no doubt but that its performance will exceed that of any other pump which raiſes the water to the ſame height, becauſe friction is completely avoided, and there can be no want of tightneſs of the piſton.—

51
But the advantage trifling.

But this is all its advantage; and, from what has been obſerved, it is but trifling. The expence would be enormous; for with whatever care the cylinders are made, the interval between the inner and outer cylinders muſt contain a very great quantity of mercury. The middle cylinder muſt be made of iron plate, and muſt be without a ſeam, for the mercury would diſſolve every ſolder. For ſuch reaſons, it has never come into general uſe. But it would have been unpardonable to have omitted the deſcription of an invention which is ſo original and ingenious; and there are ſome occaſions where it may be of great uſe, as in nice experiments for illuſtrating the theory of hydraulics, it would give the fineſt piſtons for meaſuring the preſſures of water in pipes, &c. It is on preciſely the ſame principle that the cylinder bellows, deſcribed in the article PNEUMATICS, are conſtructed.

52
Deſcription of another pump without friction.

We beg leave to conclude this part of the ſubject with the deſcription of a pump without friction, which may be conſtructed in a variety of ways by any common carpenter, without the aſſiſtance of the pump-maker or plumber, and will be very effective for raiſing a great quantity of water to ſmall heights, as in draining marſhes, marle pits, quarries, &c. or even for the ſervice of a houſe.

VII. ABCD (fig. 21.) is a ſquare trunk of carpenter's work open at both ends, and having a little ciſtern and ſpout at top. Near the bottom there is a partition made of board, perforated with a hole E, and covered with a clack. *ffff* repreſents a long cylindrical bag or pudding, made of leather or of double canvas, with a fold of thin leather ſuch as ſheepſkin between the canvas bags. This is firmly nailed to the board E with ſoft leather between. The upper end of this bag is fixed on a round board, having a hole and valve F. This board may be turned in the lathe with a groove round its edge, and the bag faſtened to it by a cord bound tight round it. The fork of the piſton-rod FG is firmly fixed into this board; the bag is kept diſtended by a number of wooden hoops or rings of ſtrong wire *ff*, *ff*, *ff*, &c. put into it at a few inches diſtance from each other. It will be proper to connect theſe hoops before putting them in, by three or four cords from top to bottom, which will keep them at their proper diſtances. Thus will the bag have the form of a barber's bellows powder-puff. The diſtance between the hoops ſhould be about twice the breadth of the rim of the wooden ring to which the upper valve and piſton-rod are fixed.

53
Its mode of operation, &c.

Now let this trunk be immerſed in the water. It is evident that if the bag be ſtretched from the compreſſed form which its own weight will give it by drawing up the piſton-rod, its capacity will be enlarged, the valve F will be ſhut by its own weight, the air in the bag will be rarefied, and the atmoſphere will preſs the water into the bag. When the rod is thruſt down again, this water will come out by the valve F, and fill part of the trunk. A repetition of the operation will have a ſimilar effect; the trunk will be filled, and the water will at laſt be diſcharged by the ſpout.

Here is a pump without friction, and perfectly tight. For the leather between the folds of canvas renders the bag impervious both to air and water. And the canvas has very conſiderable ſtrength. We know from experience that a bag of ſix inches diameter, made of ſail-cloth n°3. with a ſheep ſkin between, will bear a column of 15 feet of water, and ſtand ſix hours work *per* day for a month without failure, and that the pump is conſiderably ſuperior in effect to a common pump of the ſame dimenſions. We muſt only obſerve, that the length of the bag muſt be three times the intended length of the ſtroke; ſo that when the piſton-rod is in its higheſt poſition, the angles or ridges of the bag may be pretty acute. If the bag be more ſtretched than this, the force which muſt be exerted by the labourer becomes much greater than the weight of the column of water which he is raiſing. If the pump be laid aſlope, which is very uſual in theſe occaſional and haſty drawings, it is neceſſary to make a guide for the piſton-rod within the trunk, that the bag may play up and down without rubbing on the ſides, which would quickly wear it out.

The experienced reader will ſee that this pump is very like that of Goſſet and De la Deuille, deſcribed by Belidor Vol. II. p. 120. and moſt writers on hydraulics. It would be ſtill more like it, if the bag were on the under ſide of the partition E, and a valve placed farther down the trunk. But we think that our form is greatly preferable in point of ſtrength. When in the other ſituation, the column of water lifted by the piſton tends to *burſt* the bag, and this with a great force, as the intelligent reader well knows. But in the form recommended here, the bag is *compreſſed*, and the ſtrain on each part may be made much leſs than that which tends to burſt a bag of ſix inches diameter. The nearer the rings are placed to each other the ſmaller will the ſtrain be.

The ſame bag-piſton may be employed for a forcing pump, by placing it below the partition, and inverting the valve; and it will then be equally ſtrong, becauſe the reſiſtance in this caſe too will act by compreſſion.

We now come naturally to the conſideration of the different forms which may be given to the piſtons and valves of a pump. A good deal of what we have been deſcribing already is reducible to this head; but, having a more general appearance, changing as it were the whole form and ſtructure of the pump, it was not improper to keep theſe things together.

The great deſideratum in a piſton is, that it be as tight as poſſible, and have as little friction as is conſiſtent with this indiſpenſable quality. We have already ſaid, that the common form, when carefully executed, has theſe properties in an eminent degree. And accordingly this form has kept its ground amidſt all the improvements which ingenious artiſts have made. Mr Belidor, an author of the firſt reputation, has given the deſcription of a piſton which he highly extols, and is undoubtedly a very good one, conſtructed from principle, and extremely well compoſed. 54
Piſtons ſhould have little friction.

It conſiſts of a hollow cylinder of metal *gh* (fig. 22.) pierced with a number of holes, and having at top a flanch AB, whoſe diameter is nearly equal to that of the 55
An improved one by Belidor.

Pump.

the working-barrel of the pump. This flanch has a groove round it. There is another flanch IK below, by which this hollow cylinder is fastened with bolts to the lower end of the piston, represented in fig. 23. This consists of a plate CD, with a grooved edge similar to AB, and an intermediate plate which forms the seat of the valve. The composition of this part is better understood by inspecting the figure than by any description. The piston-rod HL is fixed to the upper plate by bolts through its different branches at G, G. This metal body is then covered with a cylindrical bag of leather, fastened on it by cords bound round it, filling up the grooves in the upper and lower plates. The operation of the piston is as follows.

A little water is poured into the pump, which gets past the sides of the piston, and lodges below in the fixed valve. The piston being pushed down dips into this water, and it gets into it by the valve. But as the piston in descending compresses the air below it, this compressed air also gets into the inside of the piston, swells out the bag which surrounds it, and compresses it to the sides of the working-barrel. When the piston is drawn up again, it must remain tight, because the valve will shut and keep in the air in its most compressed state; therefore the piston must perform well during the suction. It must act equally well when pushed down again, and acting as a forcer; for however great the resistance may be, it will affect the air within the piston to the same degree, and keep the leather close applied to the barrel. There can be no doubt therefore of the piston's performing both its offices completely; but we imagine that the adhesion to the barrel will be greater than is necessary: it will extend over the whole surface of the piston, and be equally great in every part of its surface; and we suspect that the friction will therefore be very great. We have very high authority for supposing that the adhesion of a piston of the common form, carefully made, will be such as will make it perfectly tight; and it is evident that the adhesion of Belidor's piston will be much greater, and it will be productive of worse consequences. If the leather bag is worn through in any one place, the air escapes, and the piston ceases to be compressed altogether; whereas in the common piston there will very little harm result from the leather being worn through in one place, especially if it project a good way beyond the base of the cone. We still think the common piston preferable. Belidor's piston would do much better inverted as the piston of a sucking pump; and in this situation it would be equal, but not superior, to the common.

56 Its defects.

57 Another by the same author.

Belidor describes another forcing piston, which he had executed with success, and prefers to the common wooden forcer. It consists of a metal cylinder or cone, having a broad flanch united to it at one end, and a similar flanch which is screwed on the other end. Between these two plates are a number of rings of leather strongly compressed by the two flanches, and then turned in a lathe like a block of wood, till the whole fits tight, when dry, into the barrel. It will swell, says he, and soften with the water, and withstand the greatest pressures. We cannot help thinking this but an indifferent piston. When it wears, there is nothing to squeeze it to the barrel. It may indeed be taken out and another ring or two of leather put in, or the flanches may be more strongly screwed together: but all this may be done with any kind of piston; and this has therefore no peculiar merit.

58 Objections to it.

59 Another recommended as preferable.

The following will, we presume, appear vastly preferable. ABCD (fig. 24.) is the solid wooden or metal block of the piston; EF is a metal plate, which is turned hollow or dish-like below, so as to receive within it the solid block. The piston rod goes through the whole, and has a shoulder above the plate EF, and a nut H below. Four screw-bolts, such as *i k*, *l m*, also go through the whole, having their heads *k*, *m* sunk into the block, and nuts above at *i*, *l*. The packing or stuffing, as it is termed by the workmen, is represented at NO. This is made as solid as possible, and generally consists of soft hempen twine well soaked in a mixture of oil, tallow, and rosin. The plate EF is gently screwed down, and the whole is then put into the barrel, fitting it as tight as may be thought proper. When it wears loose, it may be tightened at any time by screwing down the nuts *i l*, which cause the edges of the dish to squeeze out the packing, and compress it against the barrel to any degree.

60 Difficulties in constructing pistons.

The greatest difficulty in the construction of a piston is to give a sufficient passage through it for the water, and yet allow a firm support for the valve, and fixture for the piston rod. We shall see presently that it occasions a considerable expence of the moving power to force a piston with a narrow perforation through the water lodged in the working barrel. When we are raising water to a small height, such as 10 or 20 feet, the power so expended amounts to a fourth part of the whole, if the water-way in the piston is less than one-half of the section of the barrel, and the velocity of the piston two feet *per* second, which is very moderate. There can be no doubt, therefore, that metal pistons are preferable, because their greater strength allows much wider apertures.

61 Considerably removed in one described by Belidor.

The following piston, described and recommended by Belidor, seems as perfect in these respects as the nature of things will allow. We shall therefore describe it in the author's own words as a model, which may be adopted with confidence in the greatest works.

Plate CCCCXXVI.

"The body of the piston is a truncated metal cone CCXX (fig. 25.), having a small fillet at the greater end. Fig. 26 shows the profile, and fig. 27. the plan of its upper base; where appears a cross bar DD, pierced with an oblong mortise E for receiving the tail of the piston-rod. A band of thick and uniform leather AA (fig. 26. and 28.) is put round this cone, and secured by a brass hoop BB firmly driven on its smaller end, where it is previously made thinner to give room for the hoop.

"This piston is covered with a leather valve, fortified with metal plates GG (fig. 29.) These plates are wider than the hole of the piston, so as to rest on its rim. There are similar plates below the leather of a smaller size, that they may go into the hollow of the piston; and the leather is firmly held between the metal plates by screws H, H, which go through all. This is represented by the dotted circle IK. Thus the pressure of the incumbent column of water is supported by the plates GG, whose circular edges rest on the brim of the water-way, and thus straight edges rest on the cross bar DD of fig. 26. and 27. This valve is laid on the top of the conical box in such a manner that its middle FF rests on the cross bar. To bind all together, the

Pump.

the end of the piſton-rod is formed like a croſs, and the arms MN (fig. 30.) are made to reſt on the diameter FF of the valve, the tail EP going through the hole E in the middle of the leather, and through the mortiſe E of the croſs bar of the box; and alſo through another bar QR (fig. 28. and 29.) which is notched into the lower brim of the box. A key V is then driven into the hole T in the piſton-rod; and this wedges all faſt. The bar QR is made ſtrong; and its extremities project a little, ſo as to ſupport the braſs hoop BB which binds the leather band to the piſton-box. The adjoining ſcale gives the dimenſions of all the parts, as they were executed for a ſteam-engine near Condé, where the piſton gave complete ſatisfaction."

62 Advantages of this piſton.

This piſton has every advantage of ſtrength, tightneſs, and large water-way. The form of the valve (which has given it the name of the *butterfly-valve*) is extremely favourable to the paſſage of the water; and as it has but half the motion of a complete circular valve, leſs water goes back while it is ſhutting.

63 Another ingenious and uſeful piſton deſcribed.

The following piſton is alſo ingenious, and has a good deal of merit. OPPO (fig. 31.) is the box of the piſton, having a perforation Q, covered above with a flat valve K, which reſts in a metal plate that forms the top of the box. ABCBA is a ſtirrup of iron to which the box is fixed by ſcrews *a*, *a*, *a*, *a*, whoſe heads are ſunk in the wood. This ſtirrup is perforated at C, to receive the end of the piſton-rod, and a nut H is ſcrewed on below to keep it faſt. DEFED is another ſtirrup, whoſe lower part at DD forms a hoop like the ſole of a ſtirrup, which embraces a ſmall part of the top of the wooden box. The lower end of the piſton-rod is ſcrewed; and before it is put into the holes of the two ſtirrups (through which holes it ſlides freely) a broad nut G is ſcrewed on it. It is then put into the holes, and the nut H firmly ſcrewed up. The packing RR is then wound about the piſton as tight as poſſible till it completely fills the working barrel of the pump. When long uſe has rendered it in any degree looſe, it may be tightened again by ſcrewing down the nut G. This cauſes the ring DD to compreſs the packing between it and the projecting ſhoulder of the box at PP; and thus cauſes it to ſwell out, and apply itſelf cloſely to the barrel.

64 Another on a different principle.

We ſhall add only another form of a perforated piſton; which being on a principle different from all the preceding, will ſuggeſt many others; each of which will have its peculiar advantages. OO in fig. 32. repreſents the box of this piſton, fitted to the working barrel in any of the preceding ways as may be thought beſt. AB is a croſs bar of four arms, which is fixed to the top of the box. CF is the piſton-rod going through a hole in the middle of AB, and reaching a little way beyond the bottom of the box. It has a ſhoulder D, which prevents its going too far through. On the lower end there is a thick metal plate, turned conical on its upper ſide, ſo as to fit a conical ſeat PP in the bottom of the piſton-box.

When the piſton-rod is puſhed down, the friction on the barrel prevents the box from immediately yielding. The rod therefore ſlips through the hole of the croſs bar AB. The plate E, therefore, detaches itſelf from the box. When the ſhoulder D preſſes on the bar AB, the box muſt yield, and be puſhed down the barrels, and the water gets up through the perforation. When the piſton-rod is drawn up again, the box does not move till the plate E lodged in the ſeat PP, and thus ſhuts the water-way; and then the piſton lifts the water which is above it, and acts as the piſton of a ſucking pump.

65 Its advantages.

This is a very ſimple and effective conſtruction, and makes a very tight valve. It has been much recommended by engineers of the firſt reputation, and is frequently uſed; and from its ſimplicity, and the great ſolidity of which it is capable, it ſeems very fit for great works. But it is evident that the water-way is limited to leſs than one-half of the area of the working-barrel. For if the perforation of the piſton be one-half of the area, the diameter of the plate or ball EF muſt be greater; and therefore leſs than half the area will be left for the paſſage of the water by its ſides.

66 Obſervations on valves.

We come now to conſider the forms which may be given to the valves of a hydraulic engine.

The requiſites of a valve are, that it ſhall be tight, of ſufficient ſtrength to reſiſt the great preſſures to which it is expoſed, that it afford a ſufficient paſſage for the water, and that it do not allow much to go back while it is ſhutting.

67 Clack valves.

We have not much to add to what has been ſaid already on this ſubject. The valves which accompany the pump of fig. 5. are called *clack valves*, and are of all the moſt obvious and common; and the conſtruction deſcribed on that occaſion is as perfect as any. We only add, that as the leather is at laſt deſtroyed at the hinge by ſuch inceſſant motion, and it is troubleſome, eſpecially in deep mines, and under water, to undo the joint of the pump in order to put in a new valve, it is frequently annexed to a box like that of a piſton, made a little conical on the outſide, ſo as to fit a conical ſeat made for it in the pipe, as repreſented in fig. 33. and it has an iron handle like that of a baſket, by which it can be laid hold of by means of a long grappling-hook let down from above. Thus it is drawn up; and being very gently tapered on the ſides, it ſticks very faſt in its place.

68 Defect in them.

The only defect of this valve is, that by opening very wide when puſhed up by the ſtream of water, it allows a good deal to go back during its ſhutting again. In ſome great machines which are worked by a ſlow turning crank, the return of the piſton is ſo very ſlow, that a ſenſible loſs is incurred by this; but it is nothing like what Dr Deſaguliers ſays, one-half of a cylinder whoſe height is equal to the diameter of the valve.—For in ſuch machines, the laſt part of the upward ſtroke is equally ſlow, and the velocity of the water through the valve exceedingly ſmall, ſo that the valve is at this time almoſt ſhut.

69 Utility of the butterfly-valve.

The butterfly-valve repreſented in figures 29, &c. is free from moſt of thoſe inconveniences, and ſeems the moſt perfect of the clack valves. Some engineers make their great valves of a pyramidal form, conſiſting of four clacks, whoſe hinges are in the circumference of the water-way, and which meets with their points in the middle, and are ſupported by four ribs which riſe up from the ſides, and unite in the middle. This is an excellent form, affording the moſt ſpacious water-way, and ſhutting very readily. It ſeems to be the beſt poſſible for a piſton. The rod of the piſton is branched out on four ſides, and the branches go through the piſton-box, and are faſtened below with ſcrews. Theſe branches

branches form the support for the four clacks. We have seen a valve of this form in a pump of six feet diameter, which discharged 20 hogsheads of water every stroke, and made 12 strokes in a minute, raising the water above 22 feet.

70 ...ton ...ves

There is another form of valve, called the *button* or *tail valve*. It consists of a plate of metal AB (fig. 34.) turned conical, so as exactly to fit the conical cavity *a b* of its box. A tail CD projects from the under side, which passes through a cross bar EF in the bottom of the box, and has a little knob at the end, to hinder the valve from rising too high.

71 ...ry use...

This valve, when nicely made, is unexceptionable. It has great strength, and is therefore proper for all severe strains, and it may be made perfectly tight by grinding. Accordingly it is used in all cases where this is of indispensable consequence. It is most durable, and the only kind that will do for passages where steam or hot water is to go through. Its only imperfection is a small water-way; which, from what has been said, cannot exceed, nor indeed equal, one-half of the area of the pipe.

72 ...hough ...mewhat ...nperfect ...the water-way.

If we endeavour to enlarge the water-way, by giving the cone very little taper, the valve frequently sticks so fast in the seat that no force can detach them.— And this sometimes happens during the working of the machine; and the jolts and blows given to the machine in taking it to pieces, in order to discover what has been the reason that it has discharged no water, frequently detaches the valve, and we find it quite loose, and cannot tell what has deranged the pump. When this is guarded against, and the diminution of the water-way is not of very great consequence, this is the best form of a valve.

73 ...very ...mple ...alve described.

Analogous to this is the simplest of all valves, represented in fig. 35. It is nothing more than a sphere of metal A, to which is fitted a seat with a small portion BC of a spherical cavity. Nothing can be more effectual than this valve; it always falls into its proper place, and in every position fits it exactly. Its only imperfection is the great diminution of the water-way. If the diameter of the sphere does not considerably exceed that of the hole, the touching parts have very little taper, and it is very apt to stick fast. It opposes much less resistance to the passage of the water than the flat under-surface of the button-valve. *N. B.* It would be an improvement of that valve to give it a taper-shape below like a boy's top. The spherical valve must not be made too light, otherwise it will be hurried up by the water, and much may go back while it is returning to its place.

74 A valve by Belidor uniting every requisite.

Belidor describes with great minuteness (vol. ii. p. 221, &c.) a valve which unites every requisite. But it is of such nice and delicate construction, and its defects are so great when this exactness is not attained, or is impaired by use, that we think it hazardous to introduce it into a machine in a situation where an intelligent and accurate artist is not at hand. For this reason we have omitted the description, which cannot be given in few words, nor without many figures; and desire our curious readers to consult that author, or peruse Dr Desagulier's translation of this passage. Its principle is precisely the same with the following rude contrivance, with which we shall conclude the descriptive part of this article.

75 Another valve on the same principle.

Suppose ABCD (fig. 36.) to be a square wooden trunk. EF is a piece of oak-board, exactly fitted to the trunk in an oblique position, and supported by an iron pin which goes through it at I, one-third of its length from its lower extremity E. The two ends of this board are bevelled, so as to apply exactly to the sides of the trunk. It is evident, that if a stream of water comes in the direction BA, its pressure on the part IF of this board will be greater than that upon EI. It will therefore force it up and rush through, making it stand almost parallel to the sides of the trunk. To prevent its rising so far, a pin must be put in its way. When this current of water changes its direction, the pressure on the upper side of the board being again greatest on the portion IF, it is forced back again to its former situation; and its two extremities resting on the opposite sides of the trunk, the passage is completely stopped. This board therefore performs the office of a valve; and this valve is the most perfect that can be, because it offers the freest passage to the water, and it allows very little to get back while it is shutting; for the part IE brings up half as much water as IF allows to go down. It may be made extremely tight, by fixing two thin fillets H and G to the sides of the trunk, and covering those parts of the board with leather which applies to them; and in this state it perfectly resembles Belidor's fine valve.

76 Description of an occasional pump easily constructed.

And this construction of the valve suggests, by the way, a form of an occasional pump, which may be quickly set up by any common carpenter, and will be very effectual in small heights. Let *a b c d e* (fig. 36.) be a square box made to slide along this wooden trunk without shake, having two of its sides projecting upwards, terminating like the gable-ends of a house. A piece of wood *e* is mortised into these two sides, and to this the piston-rod is fixed. This box being furnished with a valve similar to the one below, will perform the office of a piston. If this pump be immersed so deep in the water that the piston shall also be under water, we scruple not to say that its performance will be equal to any. The piston may be made abundantly tight by covering its outside neatly with soft leather. And as no pipe can be bored with greater accuracy than a very ordinary workman can make a square trunk, we presume that this pump will not be very deficient even for a considerable suction.

77 The motion of water in pumps

We now proceed to the last part of the subject, to consider the motion of water in pumps, in reference to the force which must be employed. What we have hitherto said with respect to the force which must be applied to a piston, related only to the sustaining the water at a certain height: but in actual service we must not only do this, but we must discharge it at the place of delivery in a certain quantity; and this must require a force superadded to what is necessary for its mere support at this height.

78 An intricate subject.

This is an extremely intricate and difficult subject; and very imperfectly understood even by professed engineers. The principles on which this knowledge must be founded are of a much more abstruse nature than the ordinary laws of hydrostatics; and all the genius of Newton was employed in laying the foundation of this part of physical science. It has been much cultivated in the course of this century by the first mathematicians of Europe. Daniel and John Bernoulli have written very

79 The theory denominated *Hydrodynamics*, very elaborate treatises on the subject, under the very appofite name of HYDRODYNAMICS; in which, although they have added little or nothing to the fundamental propositions established in some sort by Newton, and acquiesced in by them, yet they have greatly contributed to our progress in it by the *methods* which they have pursued in making application of those fundamental propositions to the most important cases. It must be acknowledged, however, that both these propositions, and the extensions given them by these authors, are supported by a train of argument that is by no means unexceptionable; and that they proceed on assumptions or postulates which are but nearly true in any case, and in many are inadmissible: and it remains to this hour a wonder or puzzle how these propositions and their results correspond with the phenomena which we observe.

But fortunately this correspondence does obtain to a certain extent. And it seems to be this correspondence chiefly which has given these authors, with Newton at their head, the consistence which they place in their respective principles and methods: for there are considerable differences among them in those respects; and each seems convinced that the others are in a mistake. Messieurs d'Alembert and De la Grange have greatly corrected the theories of their predecessors, and have proceeded on postulates which come much nearer to the real state of the case. But their investigations involve us in such an inextricable maze of analytical investigation, that even when we are again conducted to the light of day by the clue which they have given us, we can make no use of what we there discovered.

80 Though imperfect is very useful. But this theory, imperfect as it is, is of great service. It generalizes our observations and experiments, and enables us to compose a *practical doctrine* from a heap of facts which otherwise must have remained solitary and unconnected, and as cumbersome in their application as the characters of the Chinese writing.

81 Fundamental proposition. The fundamental proposition of this practical hydrodynamics is, that water or any fluid contained in an open vessel of indefinite magnitude, and impelled by its weight only, will flow through a small orifice with the velocity which a heavy body would acquire by falling from the horizontal surface of the fluid. Thus, if the orifice is 16 feet under the surface of the water, it will issue with the velocity of 32 feet in a second.

Its velocity corresponding to any other depth h of the orifice under the surface, will be had by this easy proportion: "As the square root of 16 is to the square root of h; so is 32 feet to the velocity required: or, alternately, $\sqrt{16} : 32 = \sqrt{h} : v$, and $v = \frac{32\sqrt{h}}{\sqrt{16}} = \frac{32}{4}\sqrt{h}, = 8\sqrt{h}$: that is, multiply the square root of the height in feet by eight, and the product is the required velocity.

On the other hand, it frequently occurs, that we want to discover the depth under the surface which will produce a known velocity v. Therefore $\sqrt{h} = \frac{v}{8}$, and $h = \frac{v^2}{64}$; that is, divide the square of the velocity by 64, and the quotient is the depth wanted in feet.

82 Its utility. This proposition is sufficient for all our purposes. For since water is nearly a perfect fluid, and propagates all impressions undiminished, we can, in place of any pressure of a piston or other cause, substitute a perpendicular column of water whose weight is equal to this pressure, and will therefore produce the same efflux.—Thus, if the surface of a piston is half a square foot, and it be pressed down with the weight of 500 pounds, and we would wish to know with what velocity it would cause the water to flow through a small hole, we know that a column of water of this weight, and of half a foot base, would be 16 feet high. And this proposition teaches us, that a vessel of this depth will have a velocity of efflux equal to 32 feet in a second.

If therefore our pressing power be of such a kind that it can continue to press forward the piston with the force of 500 pounds, the water will flow with this velocity, whatever be the size of the hole. All that remains is, to determine what change of *actual pressure* on the piston results from the motion of the piston itself, and to change the velocity of efflux in the subduplicate ratio of the change of actual pressure.

83 Remark previous to its application. But before we can apply this knowledge to the circumstances which take place in the motion of water in pumps, we must take notice of an important modification of the fundamental proposition, which is but very obscurely pointed out by any good theory, but is established on the most regular and unexceptionable observation.

If the efflux is made through a hole in a thin plate, and the velocity is computed as above, we shall discover the quantity of water which issues in a second by observing, that it is a prism or cylinder of the length indicated by the velocity, and having its transverse section equal to that of the orifice. Thus, in the example already given, supposing the hole to be a square inch, the solid contents of this prism, or the quantity of water issuing in a second, is $1 \times 32 \times 12$ cubic inches, or 384 cubic inches. This we can easily measure by receiving it in a vessel of known dimensions. Taking this method, we uniformly find a deficiency of nearly 38 parts in 100; that is, if we should obtain 100 gallons in any number of seconds, we shall in fact get only 62. This is a most regular fact, whether the velocities are great or small, and whatever be the size and form of the orifice. The deficiency increases indeed in a very minute degree with the velocities. If, for instance, the depth of the orifice be one foot, the discharge is $\frac{6213}{10000}$; if it be 15 feet, the discharge is $\frac{6172}{10000}$.

This deficiency is not owing to a diminution of velocity; for the velocity may be easily and accurately measured by the distance to which the jet will go, if directed horizontally. This is found to correspond very nearly with the proposition, making a very small allowance for friction at the border of the hole, and for the resistance of the air. Sir Isaac Newton ascribed the deficiency with great justice to this, that the lateral columns of water, surrounding the column which is incumbent on the orifice, press towards the orifice, and contribute to the expence equally with that column. These lateral filaments, therefore, issue obliquely, crossing the motion of the central stream, and produce a contraction of the jet; and the whole stream does not acquire a parallel motion and its ultimate velocity till it

has got to fome diftance from the orifice. Careful obfervation fhowed him that this was really the cafe. But even his genius could not enable him to afcertain the motion of the lateral filaments by theory, and he was obliged to meafure every thing as he faw it. He found the diameter of the jet at the place of the greateft contraction to be precifely fuch as accounted for the deficiency. His explication has been unanimoufly acquiefced in; and experiments have been multiplied to afcertain all thofe circumftances which our theory cannot determine *à priori*. The moft complete fet of experiments are thofe of Michelotti, made at Turin at the expence of the prince of Piedmont. Here jets were made of 1, 2, 3, and 4 inches diameter; and the water received into cifterns moft accurately formed of brick, and lined with ftucco. It is the refult of thefe experiments which we have taken for a meafure of the deficiency.

We may therefore confider the water as flowing through a hole of this contracted dimenfion, or fubftitute this for the real orifice in all calculations. For it is evident that if a mouth-piece (fo to call it) were made, whofe internal fhape precifely tallied with the form which the jet affumes, and if this mouth-piece be applied to the orifice, the water will flow out without any obftruction. The veffel may therefore be confidered as really having this mouth-piece.

Nay, from this we derive a very important obfervation, "that if, inftead of allowing the water to flow through a hole of an inch area made in a thin plate, we make it flow through a hole in a thick plank, fo formed that the external orifice fhall have an inch area, but be widened internally agreeably to the fhape which nature forms, both the velocity and quantity will be that which the fundamental propofition determines. Michelotti meafured with great care the form of the great jets of three and four inches diameter, and found that the bounding curve was an elongated trochoid. He then made a mouth-piece of this form for his jet of one inch, and another for his jet of two inches; and he found the difcharges to be $\frac{979}{1000}$ and $\frac{987}{1000}$; and he, with juftice, afcribed the trifling deficiency which ftill remained, partly to friction and partly to his not having exactly fuited his mouth-piece to the natural form. We imagine that this laft circumftance was the fole caufe: For, in the firft place, the water in his experiments, before getting at his jet-holes, had to pafs along a tube of eight inches diameter. Now a jet of four inches bears too great a proportion to this pipe; and its narrownefs undoubtedly hindered the lateral columns from contributing to the efflux in their due proportion, and therefore rendered the jet lefs convergent. And, in the next place, there can be no doubt (and the obfervations of Daniel Bernoulli confirm it) but that this convergency begins within the veffel, and perhaps at a very confiderable diftance from the orifice. And we imagine, that if accurate obfervations could be made on the motion of the remote lateral particles within the veffel, and an internal mouth-piece were fhaped according to the curve which is defcribed by the remoteft particle that we can obferve, the efflux of water would almoft perfectly tally with the theory. But indeed the coincidence is already fufficiently near for giving us very valuable information. We learn that the quantity of water which flows through a hole, in confequence of its own weight, or by the action of any force, may be increafed one half by properly fhaping the paffage to this hole; for we fee that it may be increafed from 62 to near 99.

But there is another modification of the efflux, which we confefs our total incapacity to explain. If the water iffues through a hole made in a plate whofe thicknefs is about twice the diameter of the hole, or, to exprefs it better, if it iffues through a pipe whofe length is about twice its diameter, the quantity difcharged is nearly $\frac{82}{100}$ of what refults from the propofition. If the pipe be longer than this, the quantity is diminifhed by friction, which increafes as the length of the pipe increafes. If the pipe be fhorter, the water will not fill it, but detaches itfelf at the very entry of the pipe, and flows with a contracted jet. When the pipe is of this length, and the extremity is ftopped with the finger, fo that it begins to flow with a full mouth, no fubfequent contraction is obferved; but merely ftriking on the pipe with a key or the knuckle is generally fufficient to detach the water in an inftant from the fides of the pipe, and reduce the efflux to $\frac{62}{100}$.

This effect is moft unaccountable. It certainly arifes from the mutual adhefion or attraction between the water and the fides of the pipe; but how this, acting at right angles to the motion, fhould produce an increafe from 62 to 82, nearly $\frac{1}{3}$, we cannot explain. It fhows, however, the prodigious force of this attraction, which in the fpace of two or three inches is able to communicate a great velocity to a very great body of water. Indeed the experiments on capillary tubes fhow that the mutual attraction of the parts of water is fome thoufands of time greater than their weight.

We have only further to add, that every increafe of pipe beyond two diameters is accompanied with a diminution of the difcharge; but in what ratio this is diminifhed it is very difficult to determine. We fhall only obferve at prefent that the diminution is very great. A pipe of 2 inches diameter and 30 feet long has its difcharge only $\frac{54}{100}$ of what it would be if only 4 inches long. If its length be 60 feet, its difcharge will be no more than $\frac{39}{100}$. A pipe of 1 inch diameter would have a difcharge of $\frac{44}{100}$, and $\frac{31}{100}$, in the fame fituation. Hence we may conclude that the difcharge of a 4-inch pipe of 30 feet long will not exceed $\frac{2}{3}$ of what it would be if only 8 inches long. This will fuffice for our prefent purpofes; and the determination of the velocities and difcharges in long conduits from pump-machines muft be referred to the article *Water-Works*. At prefent we fhall confine our attention to the pump itfelf, and to what will contribute to its improvement.

Before we can proceed to apply this fundamental propofition to our purpofe, we muft anticipate in a loofe way a propofition of continual ufe in the conftruction of *Water-Works*.

Let water be fuppofed ftagnant in a veffel EFGH (fig. 37.), and let it be allowed to flow out by a cylindrical pipe HIKL, divided by any number of partitions B, C, D, &c. Whatever be the areas B, C, D, of thefe orifices, the velocity in the intermediate parts of the pipe will be the fame; for as much paffes through any one orifice in a fecond as paffes through any other in the fame time, or through any fection of the intervening pipe. Let this velocity in the pipe be V, and let the area of the pipe be A. The velocity in the orifices

Pump.

fices B, C, D, muſt be $\frac{VA}{B}$, $\frac{VA}{C}$, $\frac{VA}{D}$, &c. Let g be the velocity acquired in a ſecond by a heavy body. Then, by the general propoſition, the height of water in the veſſel which will produce the velocity $\frac{VA}{B}$ in the firſt orifice alone, is $\frac{V^2A^2}{2gB^2}$. After this paſſage the velocity is again reduced to V in the middle of the ſpace between the firſt and ſecond orifices. In the ſecond orifice this velocity is changed to $\frac{VA}{C}$. This alone would have required a height of water $\frac{V^2A^2}{2gC^2}$. But the water is already moving with the velocity V, which would have reſulted from a height of water in veſſel (which we ſhall, in the language of the art, call the HEAD OF WATER) equal to $\frac{V^2}{2g}$. Therefore there is only required a head of water $\frac{V^2A^2}{2gC^2}-\frac{V^2}{2g}$, or $\frac{V^2}{2g}\times\overline{\frac{A^2}{C^2}-1}$. Therefore the whole height neceſſary for producing the efflux through both orifices, ſo as ſtill to preſerve the velocity V in the intervening pipe, is $\frac{V^2}{2g}\times\overline{\frac{A^2}{B^2}+\frac{A^2}{C^2}-1}$. In like manner the third orifice D would alone require a head of water $\frac{V^2}{2g}\times\overline{\frac{A^2}{D^2}-1}$; and all the three would require a head $\frac{V^2}{2g}\times\overline{\frac{A^2}{B^2}+\frac{A^2}{C}+\frac{A^2}{D^2}-2}$. By this induction may eaſily be ſeen what head is neceſſary for producing the efflux through any number of orifices.

Let the expence or quantity of water diſcharged in an unit of time (ſuppoſe a ſecond) be expreſſed by the ſymbol Q. This is meaſured by the product of the velocity by the area of the orifice, and is therefore $=VA$, or $\frac{VA}{B}\times B$, or $\frac{VA}{C}\times C$, &c. and $V=\frac{Q^2}{A^2}$. Therefore we may compute the head of water (which we ſhall expreſs by H) in reference to the quantity of water diſcharged, becauſe this is generally the intereſting circumſtance. In this view we have $H=\frac{Q^2}{2gA}\times\overline{\frac{A^2}{B^2}+\frac{A^2}{C^2}+\frac{A^2}{D^2}-2}$: which ſhows that the head of water neceſſary for producing the diſcharge increaſes in the proportion of the ſquare of the quantity of water which is diſcharged.

84 To determine the motion of water, &c.

Theſe things being premiſed, it is an eaſy matter to determine the motion of water in a pump, and the quantity diſcharged, reſulting from the action of any force on the piſton, or the force which muſt be applied to the piſton in order to produce any required motion or quantity diſcharged. We have only to ſuppoſe that the force employed is the preſſure of a column of water of the diameter of the working barrel; and this is over and above the force which is neceſſary for merely ſupporting the water at the height of the place of delivery. The motion of the water will be the ſame in both caſes.

85 In the ing-pu

Let us, firſt of all, conſider a ſucking-pump. The motion here depends on the preſſure of the air, and will be the ſame as if the pump were lying horizontally, and communicated with a reſervoir, in which is a head of water ſufficient to overcome all the obſtructions to the motion, and produce a velocity of efflux ſuch as we deſire. And here it muſt be noted that there is a limit. No velocity of the piſton can make the water riſe in the ſuction-pipe with a greater velocity than what would be produced by the preſſure of a column of water 33 feet high; that is, about 46 feet *per* ſecond.

Let the velocity of the piſton be V, and the area of the working barrel be A. Then, if the water fills the barrel as faſt as the piſton is drawn up, the diſcharge during the riſe of the piſton, or the number of cubic feet of water *per* ſecond, muſt be $=V\times A$. This is always ſuppoſed, and we have already aſcertained the circumſtances which enſure this to happen. If, therefore, the water arrived with perfect freedom to the piſton, the force neceſſary for giving it this velocity, or for diſcharging the quantity $V\times A$ in a ſecond, would be equal to the weight of the pillar of water whoſe height is $\frac{V^2}{2g}$, and baſe A.

It does not appear at firſt ſight that the force neceſſary for producing this diſcharge has any thing to do with the obſtructions to the aſcent of the water into the pump, becauſe this is produced by the preſſure of the atmoſphere, and it is the action of this preſſure which is meaſured by the head of water neceſſary for producing the internal motion in the pump. But we muſt always recollect that the piſton, before bringing up any water, and ſupporting it at a certain height, was preſſed on both ſides by the atmoſphere. While the air ſupports the column below the piſton, all the preſſure expended in this ſupport is abſtracted from its preſſure on the under part of the piſton, while its upper part ſtill ſupports the whole preſſure. The atmoſphere continues to preſs on the under ſurface of the piſton, through the intermedium of the water in the ſuction-pipe, with the difference of theſe two forces.—Now, while the piſton is drawn up with the velocity V, more of the atmoſpheric preſſure muſt be expended in cauſing the water to follow the piſton; and it is only with the remainder of its whole preſſure that it continues to preſs on the under ſurface of the piſton. Therefore, in order that the piſton may be raiſed with the velocity V, a force muſt be applied to it, over and above the force neceſſary for merely ſupporting the column of water, equal to that part of the atmoſpheric preſſure thus employed; that is, equal to the weight of the head of water neceſſary for forcing the water up through the ſuction-pipe, and producing the velocity V in the working barrel.

Therefore let B be the area of the mouth of the ſuction-pipe, and C the area of the fixed valve, and let the ſuction-pipe be of equal diameter with the working barrel. The head neceſſary for producing the velocity V on the working barrel is $\frac{V^2}{2g}\left(\frac{A^2}{B^2}+\frac{A^2}{C^2}-1\right)$. If d expreſs the denſity of water; that is, if d be the

number

number of pounds in a cubic foot of water, then $d\,A\frac{V^2}{2g}$ will express the weight of a column whose base is A, and height $\frac{V^2}{2g}$, all being reckoned in feet. Therefore the force which must be applied, when estimated in pounds, will be $p, = \frac{d\,AV^2}{2g}\left(\frac{A^2}{B^2}+\frac{A^2}{C^2}-1.\right)$

The first general observation to be made on what has been said is, that the power which must be employed to produce the necessary motion, in opposition to all the obstacles, is in the proportion of the square of the velocity which we would produce, or the square of the quantity of water we would discharge.

We have hitherto proceeded on the supposition, that there is no contraction of the jet in passing through these two orifices. This we know would be very far from the truth. We must therefore accommodate things to these circumstances, by diminishing B and C in the ratio of the contraction, and calling the diminished areas b and c; then we have $p = \frac{A\,d\,V^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-1\right)$.

What this diminution may be, depends on the form of the parts. If the fixed valve, and the entry into the pump, are simply holes in thin plates, then $b = \frac{62}{100}$ B and $c = \frac{62}{100}$C. The entry is commonly widened or trumpet-shaped, which diminishes greatly the contraction: but there are other obstacles in the way, arising from the strainer usually put round it to keep out filth. The valve may have its contraction greatly diminished also by its box being made bell-shaped internally; nay, even giving it a cylindrical box, in the manner of fig. 33. is better than no box at all, as in fig. 5.; for such a cylindrical box will have the unaccountable effect of the short tube, and make $b = \frac{82}{100}$ B, instead of $\frac{62}{100}$ B. Thus we see that circumstances seemingly very trifling may produce great effects in the performance of a pump. We should have observed that the valve itself presents an obstacle which diminishes the motion, and requires an increase of power; and it would seem that in this respect the clack or butterfly valve is preferable to the button valve.

Example. Suppose the velocity of the piston to be 2 feet or 24 inches *per* second, and that the two contracted areas are each $\frac{1}{5}$ of the area of the pump, which is not much less than what obtains in ordinary pumps. We have $\frac{V^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-1\right) = \frac{576}{768}(25+25-1)$ $= 36{,}75$ inches, and the force which we must add to what will merely support the column is the weight of a pillar of water incumbent on the piston, and something more than three feet high. This would be a sensible portion of the whole force in raising water to small heights.

We have supposed the suction-pipe to be of the same diameter with the working barrel; but it is usual to make it of smaller diameter, generally equal to the water way of the fixed valve. This makes a considerable change in the force necessary to be applied to the piston. Let a be the area of the suction-pipe, the area of the entry being still B; and the equivalent entry without contraction being still b, we have the velocity at the entrance $= \frac{AV}{b}$, and the producing head of water $= \frac{A^2V^2}{2gb^2}$. After this the velocity is changed to $\frac{AV}{a}$ in the suction-pipe, with which the water arrives at the valve, where it is again changed to $\frac{AV}{c}$, and requires for this change a head of water equal to $\frac{A^2V^2}{2gc^2}$. But the velocity retained in the suction-pipe is equivalent to the effect of a head of water $\frac{A^2V^2}{2ga^2}$. Therefore the head necessary for producing such a current through the fixed valve, that the water may follow the piston with the velocity V, is $\frac{A^2V^2}{2g\,b^2}+\frac{A^2V^2}{2g\,c^2}-\frac{A^2V^2}{2g\,a^2}$, or $=$ $\frac{V^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-\frac{A^2}{a^2}\right)$. This is evidently less than before, because a is less than A, and therefore $\frac{A^2}{a^2}$ is greater than unity, which was the last term of the former formula. There is some advantage, therefore, derived from making the diameter of the suction-pipe less than that of the working barrel: but this is only because the passage of the fixed valve is smaller, and the inspection of the formula plainly points out that the area of the suction-pipe should be equal to that of the fixed valve. When it is larger, the water must be accelerated in its passage through the valve; which is an useless expence of force, because this velocity is to be immediately reduced to V in the working-barrel. If the foregoing example be computed with a equal to $\frac{1}{4}$ of A, we shall find the head H equal to 29 inches instead of 37.

But this advantage of a smaller suction-pipe is in all cases very moderate; and the pump is always inferior to one of uniform dimensions throughout, having the orifice at the fixed valve of the same area. And if these orifices are considerably diminished in any proportion, the head necessary for overcoming the obstacles, so that the required velocity V may still be produced in the working barrel, is greatly increased. If we suppose the area a $\frac{1}{9}$ of A, which is frequently done in house pumps, where the diameter of the suction-pipe does seldom exceed $\frac{1}{3}$ of that of the working-barrel; and suppose every thing made in proportion to this, which is also usual, because the unskilled pump-makers study a symmetry which satisfies the eye; we shall find that the pump taken as an example will require a head of water $=$ 13 feet and upwards. Besides, it must be observed that the friction of the suction-pipe itself has not been taken into the account. This alone is greater, in most cases, than all the obstructions we have been speaking of; for if this pipe is three inches diameter, and that of the working-barrel is six, which is reckoned a liberal allowance for a suction-pipe, and if the fixed valve is 25 feet above the surface of the pit-water; the friction of this pipe will amount to one-third of the whole propelling force.

Thus we have enabled the reader to ascertain the force necessary for producing any required discharge of water from a pump of known dimensions: and the converse of this determination gives us the discharge which will be produced by any given force. For making $\frac{A^2}{b^2}+\frac{A^2}{c^2}-\frac{A^2}{a^2}$, (which is a known quantity, resulting from the dimensions of the pump) $=$ M, we

 have

Pump.

have $H=\frac{V^2}{2g}M$, and $V^2=\frac{2gH}{M}$, and $V=\sqrt{\frac{2gH}{M}}$. Now H is that part of the natural power which we have at command which exceeds what is neceſſary for merely ſupporting the column of water. Thus, if we have a pump whoſe piſton has an area of $\frac{1}{4}$ of a ſquare foot, its diameter being $6\frac{3}{4}$ inches; and we have to raiſe the water 32 feet, and can apply a power of 525 pounds to the piſton; we wiſh to know at what rate the piſton will be moved, and the quantity of water diſcharged? Merely to ſupport the column of water of this height and diameter, requires 500 pounds. Therefore the remaining power, which is to produce the motion, is 25 pounds. This is the weight of a column 1 foot 4 inches high, and $H=1{,}333$ feet. Let us ſuppoſe the diameter of the ſuction-pipe $\frac{1}{2}$ of that of the working-barrel, ſo that $\frac{A}{B}=4$. We may ſuppoſe it executed in the beſt manner, having its lower extremity trumpet-ſhaped, formed by the revolution of the proper trochoid. The contraction at the entry may therefore be conſidered as nothing, and $\frac{A}{b}=4$, and $\frac{A^2}{b^2}=16$. We may alſo ſuppoſe the orifice of the fixed valve equal to the area of the ſuction-pipe, ſo that $\frac{A^2}{C^2}$ is alſo $=16$, and there is no contraction here; and therefore $\frac{A^2}{c^2}$ is alſo 16. And laſtly, $\frac{A^2}{a^2}$ is alſo 16. Therefore $\frac{A^2}{b^2}+\frac{A^2}{c^2}-\frac{A^2}{a^2}$ or M, $=16+16-16$, $=16$. We have alſo $2g=64$. Now $V=\sqrt{\frac{2gH}{M}}$. $=\sqrt{\frac{64\times 1{,}333}{16}}$, $=2{,}309$ feet, and the piſton will move with the velocity of 2 feet 4 inches nearly. Its velocity will be leſs than this, on account both of the friction of the piſton and the friction of the water in the ſuction-pipe. Theſe two circumſtances will probably reduce it to one foot eight inches; and it can hardly be leſs than this.

We have taken no notice of the friction of the water in the working-barrel, or in the ſpace above the piſton; becauſe it is in all caſes quite inſignificant. The longeſt pipes employed in our deep mines do not require more than a few inches of head to overcome it.

But there is another circumſtance which muſt not be omitted. This is the reſiſtance given to the piſton in its deſcent. The piſtons of an engine for drawing water from deep mines muſt deſcend again by their own weight in order to repeat their ſtroke. This muſt require a preponderance on that end of the working-beam to which they are attached, and this muſt be overcome by the moving power during the effective ſtroke. It makes, therefore, part of the whole work to be done, and muſt be added to the weight of the column of water which muſt be raiſed.

This is very eaſily aſcertained. Let the velocity of the piſton in its deſcent be V, the area of the pump-barrel A, and the area of the piſton-valve a. It is evident, that while the piſton deſcends with the velocity V, the water which is diſplaced by the piſton in a ſecond is $(A-a)\,V$. This muſt paſs through the hole of the piſton, in order to occupy the ſpace above, which is left by the piſton. If there were no contraction, the water would go thro' the velocity $\frac{A-a}{a}V$; but as there will always be ſome contraction, let the diminiſhed area of the hole (to be diſcovered by experiment) be b; the velocity therefore will be $V\frac{A-a}{b}$. This requires for its production a head of water $\frac{V^2}{2g}\left(\frac{A-a}{b}\right)^2$. This is the height of a column of water whoſe baſe is not A but $A-a$. Calling the denſity of water d, we have for the weight of this column, and the force p is $d\times\overline{A-a}\times\left(\frac{A-a}{b}\right)^2\times\frac{V^2}{2g}, =\frac{dV^2(A-a)^3}{2gb^2}$. This, we ſee again, is proportional to the ſquare of the velocity of the piſton in its deſcent, and has no relation to the height to which the water is raiſed.

If the piſton has a button valve, its ſurface is at leaſt equal to a; and therefore the preſſure is exerted on the water by the whole ſurface of the piſton. In this caſe we ſhall have $p=\frac{dV^2A^3}{2gb^2}$ conſiderably greater than before. We cannot aſcertain this value with great preciſion, becauſe it is extremely difficult, if poſſible, to determine the reſiſtance in ſo complicated a caſe. But the formula is exact, if b can be given exactly; and we know within very moderate limits what it may amount to. In a pump of the very beſt conſtruction, with a button valve, b cannot exceed one-half of A; and therefore $\frac{A^3}{b^2}$ cannot be leſs than 8. In this caſe, $\frac{V^2A^3}{2gb^2}$ will be $\frac{V^2}{8}$. In a good ſteam-engine pump V is about three feet per ſecond, and $\frac{V^2}{8}$ is about $1\frac{1}{8}$ feet, which is but a ſmall matter.

We have hitherto been conſidering the ſucking-pump alone: but the forcing pump is of more importance, and apparently more difficult of inveſtigation.— Here we have to overcome the obſtructions in long pipes, with many bends, contractions, and other obſtructions. But the conſideration of what relates merely to the pump is abundantly ſimple. In moſt caſes we have only to force the water into an air-veſſel, in oppoſition to the elaſticity of the air compreſſed in it, and to ſend it thither with a certain velocity, regulated by the quantity of water diſcharged in a given time. The elaſticity of the air in the air-veſſel propels it along the *Main*. We are not now ſpeaking of the force neceſſary for counterbalancing this preſſure of the air in the air-veſſel, *which is equivalent to all the ſubſequent obſtructions*, but only of the force neceſſary for propelling the water out of the pump with the proper velocity.

86 And in the forcing-pump.

We have in a manner determined this already. The piſton is ſolid, and the water which it forces has to paſs through a valve in the lateral pipe, and then to move in the direction of the Main. The change of direction requires an addition of force to what is neceſſary for merely impelling the water through the valve. Its quantity is not eaſily determined by any theory, and it varies according to the abruptneſs of the turn. It appears from experiment, that when a pipe is bent to a right angle, without any curvature or rounding, the velocity is diminiſhed about $\frac{1}{18}$. This would augment

ment the head of water about $\frac{1}{9}$. This may be added to the contraction of the valve hole. Let c be its natural area, and whatever is the contraction competent to its form increase it $\frac{1}{18}$, and call the contracted area c. Then this will require a head of water $= \frac{V^2 A^2}{2 g c^2}$. This must be added to the head $\frac{V^2}{2g}$, necessary for merely giving the velocity V to the water. Therefore the whole is $\frac{V^2}{2g}\left(\frac{A^2}{c^2}+1\right)$; and the power p necessary for this purpose is $\frac{d A V^2}{2g}\left(\frac{A^2}{c^2}+1\right)$.

It cannot escape the observation of the reader, that in all these formulæ, expressing the height of the column of water which would produce the velocity V in the working barrel of the pump, the quantity which multiplies the constant factor $\frac{d A V^2}{2g}$ depends on the contracted passages which are in different parts of the pump, and increases in the duplicate proportion of the sum of those contractions. It is therefore of the utmost consequence to avoid all such, and to make the Main which leads from the forcing-pump equal to the working barrel. If it be only of half the diameter, it has but one-fourth of the area, the velocity in the Main is four times greater than that of the piston, and the force necessary for discharging the same quantity of water is 16 times greater.

It is not, however, possible to avoid these contractions altogether, without making the main pipe wider than the barrel. For if only so wide, with an entry of the same size, the valve makes a considerable obstruction. Unskilful engineers endeavour to obviate this by making an enlargement in that part of the Main which contains the valve. This is seen in fig. 14. at the valve L. If this be not done with great judgment, it will increase the obstructions. For if this enlargement is full of water, the water must move in the direction of its axis with a diminished velocity; and when it comes into the main, it must again be accelerated. In short, any abrupt enlargement which is to be afterwards contracted, does as much harm as a contraction, unless it be so short that the water in the axis keeps its velocity till it reaches the contraction. Nothing would do

87
of experiments.

more service to an artist, who is not well founded in the theory of hydrodynamics, than to make a few simple and cheap experiments with a vessel like that of fig. 37. Let the horizontal pipe be about three inches diameter, and made in joints which can be added to each other. Let the joints be about six inches long, and the holes from one-fourth to a whole inch in diameter. Fill the vessel with water, and observe the time of its sinking three or four inches. Each joint should have a small hole in its upper side to let out the air; and when the water runs out by it, let it be stopped by a peg. He will see that the larger the pipe is in proportion to the orifices made in the partitions, the efflux is *more diminished*. We believe that no person would suspect this who has not considered the subject minutely.

All angular enlargements, all boxes, into which the pipes from different working barrels, unite their water before it goes into a Main, must therefore be avoided by an artist who would execute a good machine; and the different contractions which are unavoidable at the seats of valves and the perforations of pistons, &c. should be diminished by giving the parts a trumpet-shape.

Pump.

In the air-vessels represented in fig. 13. this is of very great consequence. The throat O, through which the water is forced by the expansion of the confined air, should always be formed in this manner. For it is this which produces the motion during the returning part of the stroke in the pump constructed like fig. 13. n° 1. and during the whole stroke in n° 2. Neglecting this seemingly trifling circumstance will diminish the performance at least one-fifth. The construction of n° 1. is the best, for it is hardly possible to make the passage of the other so free from the effects of contraction. The motion of the water during the returning stroke is very much contorted.

88
Acceleration of the motion of water in pumps.

There is one circumstance that we have not taken any notice of, viz. the gradual acceleration of the motion of water in pumps. When a force is applied to the piston, it does not in an instant communicate all the velocity which it acquires. It acts as gravity acts on heavy bodies; and if the resistances remained the same, it would produce, like gravity, an uniformly accelerated motion. But we have seen that the resistances (which are always measured by the force which just overcomes them) increase as the square of the velocity increases. They therefore quickly balance the action of the moving power, and the motion becomes uniform, in a time so short that we commit no error of any consequence by supposing it uniform from the beginning. It would have prodigiously embarrassed our investigations to have introduced this circumstance; and it is a matter of mere speculative curiosity: for most of our moving powers are unequal in their exertions, and these exertions are regulated by other laws. The pressure on a piston moved by a crank is as variable as its velocity, and in most cases is nearly in the inverse proportion of its velocity, as any mechanician will readily discover. The only case in which we could consider this matter with any degree of comprehensibility is that of a steam-engine, or of a piston which forces by means of a weight lying on it. In both, the velocity becomes uniform in a very small fraction of a second.

89
Deficiency of elementary books on this subject.

We have been very minute on this subject. For although it is the only view of a pump which is of any importance, it is hardly ever understood even by professed engineers. And this is not peculiar to hydraulics, but is seen in all the branches of practical mechanics. The elementary knowledge to be met with in such books as are generally perused by them, goes no farther than to state the forces which are in equilibrio by the intervention of a machine, or the proportion of the parts of a machine which will set two known forces in equilibrio. But when this equilibrium is destroyed by the superiority of one of the forces, the machine must move; and the only interesting question is, *what will be the motion?* Till this is answered with some precision, we have learned nothing of any importance. Few engineers are able to answer this question even in the simplest cases; and they cannot, from any confident science, say what will be the performance of an untried machine. They guess at it with a success proportioned to the multiplicity of their experience and their own sagacity. Yet this part of mechanics is as susceptible of accurate computation as the cases of equilibrium. — We therefore thought it our duty to point out the manner of proceeding so circumstantially, that every

step

ſtep ſhould be plain and eaſy, and that conviction ſhould always accompany our progreſs. This we think it has been in our power to do, by the very ſimple method of ſubſtituting a column of water acting by its weight in lieu of any natural power which we may chance to employ.

To ſuch as wiſh to proſecute the ſtudy of this important part of hydraulics in its moſt abſtruſe parts, we recommend the peruſal of the diſſertations of Mr Pitot and Mr Boſſut, in the Memoirs of the Academy of Paris; alſo the diſſertations of the Chevalier De la Borda, 1766 and 1767; alſo the *Hydraulique* of the Chevalier De Buat. We ſhall have occaſion to conſider the motion of the water in the mains of forcing or lifting pumps which ſend the water to a diſtance, in the article *Water-Works*; where the reader will ſee how ſmall is the performance of all hydraulic machines, in compariſon of what the uſual theories, founded on equilibrium only, would make him expect.

PUN, or Punn, an expreſſion where a word has at once different meanings. The practice of punning is the miſerable refuge of thoſe who wiſh to paſs for wits, without having a grain of wit in their compoſition.—James the I. of England delighted in punning; and the taſte of the ſovereign was ſtudied by the courtiers, and even by the clergy. Hence the ſermons of that age abound with this ſpecies of falſe wit. It continued to be more or leſs faſhionable till the reign of Queen Anne, when Addiſon, Swift, Pope, and Arbuthnot, with the other real wits of that claſſical age, united their efforts to baniſh punning from polite compoſition. It is ſtill admitted ſparingly in converſation; and no one will deny that a happy pun, when it comes unſought, contributes to excite mirth in a company. A profeſſed *punſter*, however, who is always pouring forth his ſenſeleſs quibbles, as Sancho Panca poured forth his proverbs, is ſuch an intolerable nuiſance in ſociety, that we do not wonder at Pope or Swift having written a pamphlet with the title of *God's Revenge againſt Punning*.

PUNCH, an inſtrument of iron or ſteel, uſed in ſeveral arts, for the piercing or ſtamping holes in plates of metals, &c. being ſo contrived as not only to perforate, but to cut out and take away the piece. The punch is a principal inſtrument of the metal-button makers, ſhoe-makers, &c.

Punch is alſo a name for a ſort of compound drink, much uſed here, and in many parts abroad, particularly in Jamaica, and ſeveral other parts of the Weſt Indies.

Its baſis is ſpring-water; which being rendered cooler, briſker, and more acid, with lemon or lime juice, and ſweetened again to the palate with fine ſugar, makes what they call *ſherbet*; to which a proper quantity of ſpirituous liquor, as brandy, rum, or arrack, being added, the liquor commences punch.

PUNCHEON, Punchin, or *Punchion*, a little block or piece of ſteel, on one end whereof is ſome figure, letter, or mark, engraven either in creux or relievo, impreſſions whereof are taken on metal, or ſome other matter, by ſtriking it with a hammer on the end not engraved. There are various kinds of theſe puncheons uſed in the mechanical arts; ſuch, for inſtance, are thoſe of the goldſmiths, cutlers, pewterers, &c.

The puncheon, in coining, is a piece of iron ſteeled, whereon the engraver has cut in relievo the ſeveral figures, arms, effigy, inſcription, &c. that there are to be in the matrices, wherewith the ſpecies are to be marked. Minters diſtinguiſh three kinds of puncheons, according to the three kinds of matrices to be made; that of the effigy, that of the croſs or arms, and that of the legend or inſcription. The firſt includes the whole portrait in relievo; the ſecond are ſmall, ſuch only containing a piece of the croſs or arms; for inſtance, a fleur-de-lis, an harp, a coronet, &c. by the aſſemblage of all which the entire matrice is formed. The puncheons of the legend only contain each one letter, and ſerve equally for the legend on the effigy ſide and the croſs ſide. See the article Coinage.

For the puncheons uſed in ſtamping the matrices wherein the types of printing characters are caſt, ſee *Letter-Foundery*.

Puncheon is alſo uſed for ſeveral iron tools, of various ſizes and figures, uſed by the engravers en creux on metals. Seal-gravers particularly uſe a great number for the ſeveral pieces of arms, &c. to be engraven, and many ſtamp the whole ſeal from a ſingle puncheon.

Puncheon, is alſo a common name for all thoſe iron inſtruments uſed by ſtone-cutters, ſculptors, blackſmiths, &c. for the cutting, inciding, or piercing their ſeveral matters.

Thoſe of ſculptors and ſtatuaries ſerve for the repairing of ſtatues when taken out of the moulds. The lockſmiths uſe the greateſt variety of puncheons; ſome for piercing hot, others for piercing cold; ſome flat, ſome ſquare, ſome round, others oval, each to pierce holes of its reſpective figure in the ſeveral parts of locks.

Puncheon, in carpentry, is a piece of timber placed upright between two poſts, whoſe bearing is too great; ſerving, together with them, to ſuſtain ſome large weights.

This term is alſo uſed for a piece of timber raiſed upright, under the ridge of a building, wherein the legs of a couple, &c. are jointed.

Puncheon, is alſo the name of a meaſure for liquids. Rum is brought from the colonies in puncheons, which are large caſks containing about 130 gallons.

PUNCTUATION, in grammar, the art of pointing, or of dividing a diſcourſe into periods, by points expreſſing the pauſes to be made therein.

The points uſed are four, viz. the period, colon, ſemi-colon, and comma. See the particular uſe of each under its proper article, Comma, Colon, Period, and Semi-colon.

In the general, we ſhall only here obſerve, that the comma is to diſtinguiſh nouns from nouns, verbs from verbs, and ſuch other parts of a period as are not neceſſarily joined together.—The ſemi-colon ſerves to ſuſpend and ſuſtain the period when too long:—the colon, to add ſome new, ſupernumerary reaſon, or conſequence, to what is already ſaid:—and the period, to cloſe the ſenſe and conſtruction, and releaſe the voice.

Punctuation is a modern art. The ancients were entirely unacquainted with the uſe of our commas, colons, &c. and wrote not only without any diſtinction of members and periods, but alſo without diſtinction of words

words: which cuſtom, Lipſius obſerves, continued till the hundred and fourth Olympiad; during which time the ſenſe alone divided the diſcourſe.

What within our own knowledge at this day puts this beyond diſpute, is the Alexandrian manuſcript, which is at preſent in the king's library at the Britiſh Muſæum. Whoever examines this, will find, that the whole is written *continuo ductu*, without diſtinction of words or ſentences. How the ancients read their works written in this manner, it is not eaſy to conceive.

After the practice of joining words together ceaſed, notes of diſtinction were placed at the end of every word. In all the editions of the *Faſti Capitolini* theſe points occur. The ſame are to be ſeen on the *Columna Roſtrata*. For want of theſe, we find much confuſion in the *Chronicon Marmoreum*, and the covenant between the Smyrnæans and Magneſians, which are both now at Oxford. In Salmaſius's edition of *Dedicatio ſtatuæ rigillæ Herodis*, the like confuſion occurs, where we find ΔΕΤΡΙΤΕ and Δευρ ιτε.

Of theſe marks of diſtinction, the Walcote inſcription found near Bath may ſerve for a ſpecimen:

IVLIUSv VITALISv FABRI
CESISv LEGv XXv Vv V
STIPENDIORUMv &c.

After every word here, except at the end of a line, we ſee this mark v. There is an inſcription in Mountfaucon, which has a capital letter laid in an horizontal poſition, by way of interſtitial mark, which makes one apt to think that this way of pointing was ſometimes according to the fancy of the graver.

P. FERRARIVS HERMES
CAECINIAE ⊣ DIGNAE
CONIVGI ⊣ KARRISSIMAE
NVMERIAE ⊣ &c.

Here we obſerve after the words a T laid horizontally, but not after each word, which proves this to be of a much later age than the former.

Having now conſidered that the preſent uſage of ſtops was unknown to the ancients, we proceed to aſſign the time in which this uſeful improvement of language began.

As it appears not to have taken place while manuſcripts and monumental inſcriptions were the only known methods to convey knowledge, we muſt conclude that it was introduced with the art of printing. The 14th century, to which we are indebted for this invention, did not, however, beſtow thoſe appendages we call *ſtops*: whoever will be at the pains to examine the firſt printed books, will diſcover no ſtops of any kind; but arbitrary marks here and there, according to the humour of the printer. In the 15th century, we obſerve their firſt appearance. We find, from the books of this age, that they were not all produced at the ſame time; thoſe we meet with there in uſe, being only the comma, the parentheſis, the interrogation, and the full point. To prove this, we need but look into Bale's Acts of Engliſh Votaries, black-letter, printed 1550. Indeed, in the dedication of this book, which is to Edward VI. we diſcover a colon: but, as this is the only one of the kind throughout the work, it is plain this ſtop was not eſtabliſhed at this time, and ſo warily put in by the printer; or if it was, that it was not in common uſe. Thirty years after this time, in that ſenſible and judicious performance of Sir Thomas Elyot, entitled *The Governour*, imprinted 1580, we ſee the colon as frequently introduced as any other ſtop; but the ſemi-colon and the admiration were ſtill wanting, neither of theſe being viſible in this book. In Hackluyt's voyages, printed 1599, we ſee the firſt inſtance of a ſemi-colon: and, as if the editors did not fully apprehend the propriety of its general admiſſion, it is but ſparingly introduced. The admiration was the laſt ſtop that was invented; and ſeems to have been added to the reſt in a period not ſo far diſtant from our own time.

Thus we ſee, that theſe notes of diſtinction came into uſe as learning was gradually advanced and improved; one invention indeed, but enlarged by ſeveral additions.

PUNCTUM SALIENS, in anatomy, the firſt rudiments of the heart in the formation of the fœtus, where a throbbing motion is perceived. This is ſaid to be eaſily obſerved with a microſcope in a brood-egg, wherein, after conception, we ſee a little ſpeck or cloud, in the middle whereof is a ſpot that appears to beat or leap a conſiderable time before the fœtus is formed for hatching. See the article FOETUS, and ANATOMY, p. 741, &c.

PUNCTUM *ſtans*, a phraſe by which the ſchoolmen vainly attempted to bring within the reach of human comprehenſion the poſitive eternity of God. Thoſe ſubtile reaſoners ſeem to have diſcovered that nothing, which is made up of parts whether continuous or diſcrete, can be abſolutely infinite, and that therefore eternity cannot conſiſt of a boundleſs ſeries of ſucceſſive moments. Yet, as if ſuch a ſeries had always exiſted and were commenſurate in duration with the ſupreme Being, they compared his eternity to one of the moments which compoſe the flux of time arreſted in its courſe; and to this eternal moment they gave the name of *punctum ſtans*, becauſe it was ſuppoſed to ſtand ſtill, whilſt the reſt followed each other in ſucceſſion, all vaniſhing as ſoon as they appeared. We need not waſte time or room in expoſing the abſurdity of this conceit, as we have elſewhere endeavoured, in the beſt manner that we can, to aſcertain the meaning of the words *eternity* and *infinity*, and to ſhow that they cannot be predicated of time or ſpace, of points or moments, whether flowing or ſtanding ſtill. (See METAPHYSICS, Part II. chap. 7. 8. and Part III. chap. 6.)

PUNCTURE, in ſurgery, any wound made by a ſharp-pointed inſtrument.

PUNCTURE, in farriery. See there, § xl. 3.

PUNDITS, or PENDITS, learned Bramins devoted to the ſtudy of the Shanſcrit language, and to the ancient ſcience, laws, and religion of Hindoſtan. See PHILOSOPHY, nº 4—12.

PUNICA, the POMEGRANATE TREE: A genus of the monogynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid ſuperior; there are five petals; the fruit is a multilocular and polyſpermous apple.

Species. 1. The granatum, or common pomegranate, riſes with a tree ſtem, branching numerouſly all the way from the bottom, growing 18 or 20 feet high; with ſpear-ſhaped, narrow oppoſite leaves; and the branches terminated by moſt beautiful large red flowers, ſucceeded by large roundiſh fruit as big as an orange, having a hard rind filled with ſoft pulp and numerous ſeeds. There is a variety with double flowers, remarkably

ably beautiful; and one with striped flowers. 2. The nana, or dwarf American pomegranate, rises with a shrubby stem branching four or five feet high, with narrow short leaves and small red flowers, succeeded by small fruit; begins flowering in June, and continues till October.

Culture. Both these species are propagated by layers: the young branches are to be chosen for this purpose, and autumn is the proper time for laying them. Those of the common sort may be trained either as half or full standards, or as dwarfs. But those designed for walls must be managed as directed for peaches.

Uses. The dried flowers of the double-flowered pomegranate are possessed of an astringent quality; for which reason they are recommended in diarrhœas, dysenteries, &c. where astringent medicines are proper. The rind of the fruit is also a strong astringent, and as such is occasionally made use of.

PUNISHMENT, in law, the penalty which a person incurs on the commission of a crime. See the article *Crime and Punishment.*

The ingenuity of men has been much exerted to torment each other; but the following are the punishments that have been usually adopted in the different countries of the world. The capital punishments have been beheading, crucifixion, burning, roasting, drowning, scalping, hanging by the neck, the arm, or the leg, starving, sawing, exposing to wild beasts, rending asunder by horses drawing opposite ways, burying alive, shooting, blowing from the mouth of a cannon, compulsory deprivation of sleep, rolling in a barrel stuck with nails pointed inwards, poisoning, pressing slowly to death by a weight laid on the breast, casting headlong from a rock, tearing out the bowels, pulling to pieces with red-hot pincers, the rack, the wheel, impaling, fleaing alive, &c. &c.

The punishments short of death have been, fine, pillory, imprisonment, compulsory labour at the mines, galleys, highways, or correction-house; whipping, bastonading, mutilation by cutting away the ears, the nose, the tongue, the breasts of women, the foot, the hand; squeezing the marrow from the bones with screws or wedges, castration, putting out the eyes, banishment, running the gauntlet, drumming, shaving off the hair, burning on the hand or forehead, &c.

PUNNING. See Pun.

PUPIL, in the civil law, a boy or girl not yet arrived at the age of puberty; i. e. the boy under 14 years, the girl under 12.

Pupil is also used in universities, &c. for a youth under the education or discipline of any person.

Pupil, in anatomy, a little aperture in the middle of the uvea and iris of the eye, through which the rays of light pass to the crystalline humour, in order to be painted on the retina, and cause vision. See Anatomy, p. 765, &c.

PURCELL (Henry), a justly celebrated master of music, began early to distinguish himself. As his genius was original, it wanted but little forming, and he rose to the height of his profession with more ease than others pass through their rudiments. He was made organist to Westminster abbey in the latter end of the reign of Charles II. In that of William, he set several songs for Dryden's *Amphytrion* and his *King Arthur*, which were received with just applause. His notes in his operas were admirably adapted to his words, and so echoed to the sense, that the sounds alone seemed capable of exciting those passions which they never failed to do in conjunction. His music was very different from the Italian. It was entirely English, and perfectly masculine. His principal works have been published under the title of *Orpheus Britannicus*. He died in 1695, in the 37th year of his age; and was interred in Westminster abbey, where a monument is erected to his memory.

PURCHAS (Samuel), an English divine, famous for compiling a valuable collection of voyages, was born in 1577, at Thacksted in Essex. After studying at Cambridge, he obtained the vicarage of Eastwood in his native county; but leaving that cure to his brother, he settled in London, in order to carry on the great work in which he was engaged. He published the first volume in folio in 1613, and the four last, 12 years after, under the title of *Purchas his Pilgrimage, or Relations of the world, and the Religions observed in all ages and places.* Meanwhile he was collated to the rectory of St Martin's, Ludgate, in London, and made chaplain to Dr Abbot, archbishop of Canterbury. His *Pilgrimage*, and the learned Hackluyt's *Voyages*, led the way to all the other collections of that kind, and have been justly valued and esteemed. But unhappily, by his publishing, he involved himself in debt: however, he did not die in prison, as some have asserted; but at his own house, about the year 1628.

PURCHASE, in law, the buying or acquiring of lands, &c. with money, by deed or agreement, and not by descent or right of inheritance.

Purchase, in the sea-language, is the same as *draw in:* thus, when they say, the capstan purchases a-pace, they only mean, it draws in the cable a-pace.

PURE, something free from any admixture of foreign or heterogeneous matters.

PURFLEW, a term in heraldry, expressing ermins, peans, or any of the furs, when they compose a bordure round a coat of arms: thus they say, He beareth gules, a bordure, purflew, vairy; meaning, that the bordure is vairy.

PURGATION, the art of purging, scouring, or purifying a thing, by separating, or carrying off any impurities found therein. Thus,

In pharmacy, purgation is the cleansing of a medicine by retrenching its superfluities. In chemistry, it is used for the several preparations of metals and minerals intended to clear them of their impurities, more usually called *purification* and *refining*. See Refining.

In medicine, purgation is an excretory motion arising from a quick and orderly contraction of the fleshy fibres of the stomach and intestines, whereby the chyle, corrupted humours, and excrements lodged therein, are protruded further and further, and at length quite excluded the body by stool. See Materia Medica.

For the menstrual purgation of women, see Menses.

Purgation, in law, signifies the clearing a person's self of a crime of which he is suspected and accused before a judge. This purgation is either canonical or vulgar. Canonical purgation is prescribed by the canon-law, and the form thereof in the spiritual court is usually thus: The person suspected takes his oath that he is innocent of the crime charged against him; and at the same

Purgative, Purgatory. same time brings some of his neighbours to make oath that they believe he swears truly. Vulgar purgation was anciently by fire or water, or else by combat, and was practised here till abolished by our canons. See BATTEL *in law*, ORDEAL, &c.

PURGATIVE or *PURGING Medicines*, medicaments which evacuate the impurities of the body by stool, called also *cathartics*.

PURGATORY, a place in which the just, who depart out of this life, are supposed to expiate certain offences which do not merit eternal damnation. Broughton has endeavoured to prove, that this notion has been held by Pagans, Jews, and Mahometans, as well as by Christians; and that in the days of the Maccabees the Jews believed that sin might be expiated by sacrifice after the death of the sinner, cannot be questioned.

Papist misrepresented and represented. Much abuse has been poured upon the church of Rome for her doctrine of purgatory, and many false representations have been made of the doctrine itself. The following view of it is taken from a work which is considered as a standard by the British Catholics. 1. Every sin, how slight soever, though no more than an idle word, as it is an offence to God, deserves punishment from him, and will be punished by him hereafter, if not cancelled by repentance here. 2. Such small sins do not deserve eternal punishment. 3. Few depart this life so pure as to be totally exempt from spots of this nature, and from every kind of debt due to God's justice. 4. Therefore few will escape without suffering something from his justice for such debts as they have carried with them out of this world; according to that rule of divine justice, by which he treats every soul hereafter according to its works, and according to the state in which he finds it in death. From these propositions, which the Papist considers as so many self-evident truths, he infers that there must be some third place of punishment; for, since the infinite goodness of God can admit nothing into heaven which is not clean and pure from all sin both great and small; and his infinite justice can permit none to receive the reward of bliss, who as yet are not out of debt, but have something in justice to suffer; there must of necessity be some place or state, where souls, departing this life, pardoned as to the eternal guilt or pain, yet obnoxious to some temporal penalty, or with the guilt of some venial faults, are purged and purified before their admittance into heaven. And this is what he is taught concerning purgatory. Which, though he knows not where it is, of what nature the pains are, or how long each soul is detained there; yet he believes, that those that are in this place, being the living members of Jesus Christ, are relieved by the prayers of their fellow members here on earth, as also by alms and masses offered up to God for their souls. And as for such as have no relations or friends to pray for them, or give alms, or procure masses for their relief; they are not neglected by the church, which makes a general commemoration of all the faithful departed in every mass, and in every one of the canonical hours of the divine office.

Such is the Popish doctrine of purgatory, which is built chiefly upon 2 Macc. xii. 43, 44, 45; St Matth. xii. 31, 32; and 1 Cor. iii. 15. By Protestants the books of Maccabees are not acknowledged to be inspired scripture; but if they were, the texts referred to would rather prove that there is no such place as purgatory, since Judas did not expect the souls departed to reap any benefit from his sin-offering till the resurrection. Our Saviour, in St Luke, speaks of remission in *this world* and in the world to *come*; but surely neither of these is purgatory. The world to come is the state after the resurrection, and the remission spoken of is the sentence of absolution to be pronounced on the penitent from the seat of general judgment. In the obscure verse referred to in the epistle to the Corinthians, the apostle is, by the best interpreters, thought to speak of the difficulty with which Christians should be saved from the destruction of Jerusalem. Of the state of souls departed he cannot well be supposed to speake, as upon disembodied spirits fire could make no impression. We cannot help, therefore, thinking with the church of England, that "the Romish doctrine of purgatory is a fond thing, vainly invented, and grounded on no warranty of scripture;" but we must confess at the same time, that it appears to us to be a very harmless error, neither hostile to virtue nor dangerous to society. See RESURRECTION.

Purification ‖ Purlieu.

PURIFICATION, in matters of religion, a ceremony which consists in cleansing any thing from a supposed pollution or defilement.

The Pagans, before they sacrificed, usually bathed or washed themselves in water; and they were particularly careful to wash their hands, because with these they were to touch the victims consecrated to the gods. It was also customary to wash the vessel with which they made their libations. The Mahometans also use purifications previous to the duty of prayer; which are also of two kinds, either bathing, or only washing the face, hands, and feet. The first is required only in extraordinary cases, as after having lain with a woman, touched a dead body, &c. But lest so necessary a preparation for their devotions should be omitted, either where water cannot be had, or when it may be of prejudice to a person's health, they are allowed in such cases to make use of fine sand, or dust instead of it; and then they perform this duty by clapping their open hands on the sand, and passing them over the parts, in the same manner as if they were dipped in water.

There were also many legal purifications among the Hebrews. When a woman was brought to bed of a male child, she was esteemed impure for 40 days; and when of a female, for 60: at the end of which time she carried a lamb to the door of the temple to be offered for a burnt-offering, and a young pigeon or turtle for a sin-offering; and by this ceremony she was cleansed or purified.

PURIM, or *The FEAST of LOTS*, a solemn festival of the Jews, instituted in memory of the deliverance they received, by means of Mordecai and Esther, from Haman's wicked attempt to destroy them.

PURITAN, a name formerly given in derision to the dissenters from the church of England, on account of the profession to follow the pure word of God, in opposition to all traditions and human constitutions. It was likewise given in the primitive church to the Novatian schismatics, because they would never admit to communion any one who from dread of death had apostatized from the faith.

PURITY, the freedom of any thing from foreign admixture.

PURITY of Style. See ORATORY, p. 411, &c.

PURLIEU, signifies all that ground near any forest, which

which being made foreſt by King Henry II. Richard I. and King John, was afterwards by perambulations and grants of Henry III. ſevered again from the ſame, and made purlieu; that is to ſay, pure and free from the laws of the foreſt.—The word is derived from the French *pur* "pure," and *lieu* "place."

PURLINS, in building, thoſe pieces of timber that lie acroſs the rafters on the inſide, to keep them from ſinking in the middle of their length.

By the act of parliament for rebuilding London, it is provided, that all purlins from 15 feet 6 inches to 18 feet 6 inches long, be in their ſquare 9 inches and 8 inches; and all in length from 18 feet 6 inches to 21 feet 6 inches, be in their ſquare 12 inches and 9 inches.

PURPLE, a colour compoſed of a mixture of red and blue. See *Colour-Making*, n° 29. and Dying, n° 92.

PURPURA, in natural hiſtory. See Murex: where we have given an account of the Tyrian method of dying purple with a liquid extracted from the fiſh. It has been affirmed, however, that no ſuch method was ever practiſed. "At Tyre (ſays Mr Bruce) I engaged two fiſhermen, at the expence of their nets, to drag in thoſe places where they ſaid ſhell-fiſh might be caught, in hopes to have brought out one of the famous purple-fiſh. I did not ſucceed; but in this I was, I believe, as lucky as the old fiſhers had ever been. The purple fiſh at Tyre ſeems to have been only a concealment of their knowledge of cochineal; as, had they depended upon the fiſh for their dye, if the whole city of Tyre applied to nothing elſe but fiſhing, they would not have coloured 20 yards of cloth in a year."

PURPURE, in heraldry. The colour ſo called, which ſignifies *purple*, is in engraving repreſented by diagonal lines, from the left to the right. See Heraldry, p. 441. and Plate CCXXVII. fig. ii. n° 6.

It may ſerve to denote an adminiſtrator of juſtice, a lawgiver, or a governor equal to a ſovereign: and, according to G. Leigh, if it is compounded with

Or,	it ſignifies	Riches.
Arg.		Quietneſs.
Gul.		Politics.
Az.		Fidelity.
Ver.		Cruelty.
Sab.		Sadneſs.

PURPUREUS. See Convolvulus, n° 3.

PURRE, or Perkin. See Husbandry, n° 238.

PURSER, an officer aboard a man of war, who receives her victuals from the victualler, ſees that it be well ſtowed, and keeps an account of what he every day delivers to the ſteward. He alſo keeps a liſt of the ſhip's company, and ſets down exactly the day of each man's admiſſion, in order to regulate the quantity of proviſions to be delivered out, and that the paymaſter or treaſurer of the navy may iſſue out the deburſements, and pay off the men, according to his book.

PURSLAIN, in botany. See Portulaca.

PURVIEW, a term uſed by ſome lawyers for the body of an act of parliament, or that part which begins with "Be it enacted &c." as contradiſtinguiſhed from the preamble.

PURULENT, in medicine, ſomething mixed with, or partaking of, pus or matter.

PUS, in medicine, a white or yellowiſh matter deſigned by nature for the healing and cementing of wounds and ſores.

The origin and formation of pus is as much unknown as that of any other animal fluid. In an inaugural diſſertation publiſhed at Edinburgh by Dr Hendy, the author ſuppoſes pus to be a ſecreted fluid. It has been thought by many, that pus is either a ſediment from ſerum when beginning to putrefy, or that it is the ſame fluid inſpiſſated by the heat of the body. But both theſe opinions are refuted by ſome experiments of our author, which ſhow, that pus is much leſs inclined to putrefaction than ſerum, and the putrefaction of both is haſtened by an addition of ſome of the red part of the blood. Some other experiments were made in order to try whether pus could be artificially produced. A thin piece of lamb's fleſh, applied to an ulcer diſcharging laudable pus, and covered over with lead, did not aſſume the appearance of pus, but became fetid, and was much leſſened. Serum, in its inflammatory and in its ordinary ſtate, and lymph in different ſtates, were applied to the ſame ulcer, which ſtill diſcharged good pus; but none of theſe were converted into pus; on the contrary, they became very putrid.

In oppoſition to theſe arguments of our author, however, it may be alleged, that if pus was a ſecreted fluid, the veſſels by which it was ſecreted would certainly be viſible; but no ſuch thing has ever been obſerved: on the contrary, it is certain that pus cannot be formed unleſs the air is excluded from the wound. Theſe diſputes, however, are of no great conſequence: but in ſome caſes it becomes a matter of real importance to diſtinguiſh pus from mucus; as thus we may be enabled to know whether a cough is conſumptive, or merely catarrhous. See Mucus. Mr Home, in a diſſertation on the properties of pus, in which he avails himſelf of the experiments of Mr Hunter, as delivered in his *Phyſiological Lectures*, ſays, "that the characteriſtic of pus is its being compoſed of globules; and he thinks that the preſence of globules ſeems to depend upon the pus being in a perfect ſtate. It differs from the blood in the colour of the globules; in their not being ſoluble in water, which thoſe of the blood are; and from the fluid in which they ſwim being coagulable by a ſolution of ſal ammoniac, which ſerum is not." Reſpecting the formation of pus, our author adopts the idea ſuggeſted by Mr Hunter, that the veſſels of the part aſſume the nature of a gland, and ſecrete a fluid which becomes pus. Mr Home aſcertains, by experiment, that pus, at its formation, is not globular, but a tranſparent fluid, of a conſiſtence, in ſome ſort, reſembling jelly; and that the globules are formed while lying upon the ſurface of the ſore; requiring, in ſome inſtances, while the influence of the external air is excluded, fifteen minutes for that purpoſe.

PUSTULE, a pimple, or ſmall eruption on the ſkin full of pus; ſuch as the eruptions of the ſmall-pox.

PUTAMINEÆ, (from *putamen* "a ſhell,") the name of the 25th order of Linnæus's fragments of a natural method; conſiſting of a few genera of plants allied in habit, whoſe fleſhy ſeed-veſſels or fruit is frequently covered with a hard woody ſhell. See Botany, p. 462.

PUTEOLI, (Livy, Strabo): a town of Campania;

Puteoli || Putrefaction.

Swinburne's Travels in the Two Sicilies.

so called either from its wells, there being many hot and cold ſprings thereabouts; or from its ſtench, *putor*, cauſed by ſulphureous exhalations, (Varro, Strabo). It is now called *Puzzuoli*, and is pleaſantly and advantageouſly ſituated for trade. In a very remote age, the Cumeans made it their arſenal and dockyard; and to this naval eſtabliſhment gave the ſublime appellation of *Dicearchia* or *Juſt Power*.

The Romans were well aware of the utility of this port, and took great pains to improve its natural advantages. Nothing remains of their works but a line of piers, built to break the force of a rolling ſea: they are vulgarly called the *bridge of Caligula*, becauſe that madman is ſaid to have marched in triumph from Puzzuoli to Baia on a bridge; but his was a bridge of boats.

The ruins of its ancient edifices are widely ſpread along the adjacent hills and ſhores. An amphitheatre ſtill exiſts entire in moſt of its parts, and the temple of Serapis offers many curious ſubjects of obſervation; half of its buildings are ſtill buried under the earth thrown upon it by volcanical commotions, or accumulated by the crumblings of the hill; the incloſure is ſquare, environed with buildings for prieſts and baths for votaries; in the centre remains a circular platform, with four flights of ſteps up to it, vaſes for fire, a centrical altar, rings for victims, and other appendages of ſacrifice, entire and not diſplaced; but the columns that held its roof have been removed to the new palace of Caſerta (ſee CASERTA). Behind this round place of worſhip ſtand three pillars without capitals, part of the pronaos of a large temple; they are of cipolline marble, and at the middle of their height are full of holes eaten in them by the file-fiſh *.

* Pholas Dactylus, Linn.

The preſent city contains near 10,000 inhabitants, and occupies a ſmall peninſula; the cathedral was a pagan temple, dedicated to the divinities that preſided over commerce and navigation. E. Long. 14. 40. N. Lat. 41. 15.

In the neighbourhood of Puteoli are many relicks of antient grandeur, of which none deſerves more attention than the Campanian way paved with lava, and lined on each ſide with venerable towers, the repoſitories of the dead, which are richly adorned with ſtucco in the inſide. This road was made in a moſt ſolid expenſive manner by order of Domitian, and is frequently the ſubject of encomium in the poems of Statius.

PUTI CARAJA, in botany, is a genus of Indian plants, of which the characters, as given by Sir William Jones in the Aſiatic Reſearches, vol. ii. p. 351. are theſe. The calyx is five-cleft, the corolla has five equal petals, the pericarpium a thorny legumen and two ſeeds, the leaves oval and pinnated, and the ſtem armed. "The ſeeds (ſays the learned Preſident) are very bitter, and perhaps tonic; ſince one of them, bruiſed and given in two dozes, will, as the Hindoos aſſert, cure an intermittent fever."

PUTORIUS, in zoology. See MUSTELA.

PUTREFACTION, one of the natural proceſſes, directly oppoſite to the life of animals and vegetables, by which organized bodies are diſſolved, and reduced to what may be called their *original elements*.

Putrefaction differs from chemical ſolution; becauſe, in the latter, the diſſolved bodies are kept in their ſtate of ſolution by being combined with a certain agent from which they cannot eaſily be ſeparated; but in putrefaction, the agent which diſſolves the body appears not to combine with it in any manner of way, but merely to ſeparate the parts from each other.—It differs alſo from the reſolution of bodies by diſtillation with violent fire; becauſe, in diſtillation new and permanent compounds are formed, but by putrefaction every thing ſeems to be reſolved into ſubſtances much more ſimple and indeſtructible than thoſe which are the reſult of any chemical proceſs.

The bodies moſt liable to putrefaction are thoſe of animals and vegetables, eſpecially when full of juices. Stones, though by the action of the weather they will moulder into duſt, yet ſeem not to be ſubject to any thing like a real putrefaction, as they are not reſolved into any other ſubſtance than ſand, or ſmall duſt, which ſtill preſerves its lapideous nature. In like manner, vegetables of any kind, when deprived of their juices by drying, may be preſerved for many ages without being ſubjected to any thing like a putrefactive proceſs. The ſame holds good with reſpect to animals; the parts of which, by ſimple drying, may be preſerved in a ſound ſtate for a much longer time than they could be without the previous exhalation of their juices.

Putrefaction is generally allowed to be a kind of fermentation, or rather to be the laſt ſtage of that proceſs; which, beginning with the vinous fermentation, goes on through the acetous, to the ſtage of putridity, where it ſtops. It is argued, however, and ſeemingly not without a great deal of reaſon, that if putrefaction is a fermentation, it muſt neceſſarily be a kind diſtinct from either the vinous or acetous; ſince we frequently obſerve that it takes place where neither the vinous nor the acetous ſtages have gone before; of conſequence, it muſt be, in ſome caſes at leaſt, entirely independent of and unconnected with them. In ſeveral other reſpects it differs ſo much from theſe proceſſes, that it ſeems in ſome degree doubtful whether it can with propriety be called a *fermentation* or not. Both the vinous and acetous fermentations are attended with a conſiderable degree of heat: but in the putrefaction of animal matters eſpecially, the heat is for the moſt part ſo ſmall, that we cannot be certain whether there is any degree of it or not produced by the proceſs. In caſes, indeed, where the quantity of corrupting animal matter is very great, ſome heat may be perceived: and accordingly Dr Monro tells us, that he was ſenſible of heat on thruſting his hand into the fleſh of a dead and corrupting whale. But the moſt remarkable difference between the putrefactive fermentation and that of the vinous and acetous kinds is, that the end of both theſe proceſſes is to produce a new and permanent compound; but that of the putrefactive proceſs is not to produce any new form, but to deſtroy, and reſolve one which already exiſts into the original principles from which all things ſeem to proceed. Thus, the vinous fermentation produces ardent ſpirits; the acetous, vinegar: but putrefaction produces nothing but earth, and ſome effluvia, which, though moſt diſagreeable, and even poiſonous to the human body, yet, being imbibed by the earth and vegetable creation, give life to a new race of beings. It is commonly ſuppoſed, indeed, that volatile alkali is a production of the putrefactive proceſs: but this ſeems liable to diſpute. The vapour of pure volatile alkali is not hurtful to the human frame, but that of putrefying ſubſtances is exceedingly ſo; and, excepting in the caſe of urine, the

Putrefaction.

generation of volatile alkali in putrid ſubſtances is very equivocal. This ſubſtance, which produces more alkali than any other, is much leſs offenſive by its putrid fetor than others; and all animal ſubſtances produce a volatile alkali on being expoſed to the action of fire, of quicklime, or of alkaline ſalts. In theſe caſes the volatile alkali is not ſuppoſed to be produced by the quicklime or fixed ſalt, but only to be extricated from a kind of ammoniacal ſalt pre-exiſting in the animal matters; the probability is the ſame in the other caſe, viz. that volatile alkali is not produced, but only extricated, from theſe ſubſtances by putrefaction.

The only thing in which the putrefactive fermentation agrees with the other kinds is, that in all the three there is an extrication of fixed air. In the putrefactive proceſs, it has been thought that this eſcape of the fixed air deprives the body of its coheſion: and Dr Macbride has written a treatiſe, in which he endeavours to prove, that fixed air is the very power of coheſion itſelf, and that all bodies when deprived of their fixed air entirely loſe their coheſion. According to this hypotheſis, the cauſe of putrefaction is the eſcape of fixed air: but it is impoſſible to give a reaſon why fixed air, after having ſo long remained in a body, and preſerved its coheſion, ſhould of a ſudden begin to fly off without being acted upon by ſomething elſe. To a ſimilar objection the hypotheſis of thoſe is liable, who ſuppoſe putrefaction to be occaſioned by the eſcape of phlogiſton; for phlogiſton is now known to be a chimera: and though it were a reality, it would not fly off without ſomething to carry it off, any more than fixed air. Animalcules have been thought to be the cauſe of putrefaction: but if animal ſubſtances are covered ſo as to exclude the acceſs of flies or other inſects, no ſuch animalcules are to be diſcovered though putrefaction has taken place; and indeed it requires little proof to convince us, that animals are produced in corrupted bodies only becauſe ſuch ſubſtances prove a proper nidus for the eggs of the parent inſects.

To underſtand the true cauſe of putrefaction, we muſt take notice of the circumſtances in which the proceſs goes on moſt rapidly. Theſe are, heat, a little moiſture, and confined air. Extreme cold prevents putrefaction, as well as perfect dryneſs; and a free circulation of air carries off the putrid effluvia; a ſtagnation of which ſeems to be neceſſary for carrying on the proceſs. It ſeems alſo to hold pretty generally, that putrefying bodies ſwell and become ſpecifically lighter; for which reaſon the carcaſes of dead animals, after having ſunk in water, riſe to the top and float. This laſt phenomenon, as has been obſerved under the article Blood, n° 29. ſhows that theſe bodies have received a certain quantity of an elaſtic principle from the air, which thus ſwells them up to ſuch a ſize. It may be ſaid indeed, that this increaſe of ſize in putrefying bodies is owing only to the extrication of air within themſelves: but this amounts to the ſame thing; for the air which exiſts internally in the body of any animal, is entirely diveſted of elaſticity while it remains there, and only ſhows its elaſtic properties upon being extricated. The elaſtic principle which combines with the air fixed in the animal ſubſtance, therefore, muſt come from the external atmoſphere; and conſequently the agent in putrefaction muſt be the elaſtic principle of the atmoſphere itſelf, probably the ſame with elementary fire.

But, granting this to be true, it is difficult to ſhow why putrefaction ſhould not take place in a living body as well as in a dead one; ſeeing the one is as much expoſed to the action of the air as the other. This difficulty, however, is not peculiar to the preſent hypotheſis; but will equally occur whatever we may ſuppoſe the cauſe of putrefaction to be. The difficulty ſeems to be a little cleared up by Dr Prieſtley, who ſhows, that, by means of reſpiration, the body is freed from many noxious effluvia which would undoubtedly deſtroy it; and by the retention of which, he thinks, a living body would putrefy as ſoon as a dead one. The way in which reſpiration prevents the putrefaction of the body, is evidently the ſame with that in which the wind prevents fiſh or fleſh hung up in it from becoming putrid. The conſtant inſpiration of the air is like a ſtream of that element continually blown upon the body, and that not only upon its ſurface, but into it; by which means putrefaction is prevented in thoſe parts that are moſt liable to become putrid. On the other hand, the elaſtic principle received from the air by the blood *, by invigorating the powers of life, quickening the circulation, and increaſing perſpiration, enables the body to expel noxious particles from other parts of the body which cannot conveniently be expelled by the lungs.

* See Blood, n° 29.

This leads us to conſider the reaſon why a free expoſure to the air prevents the coming on of putrefaction, or why the confining of the putrid effluvia ſhould be ſo neceſſary to this proceſs. Here it will be proper to recollect, that putrefaction is a ſimple reſolution of the body into earth, air, &c. of which it ſeems originally to have been compoſed. This reſolution is evidently performed by an expanſive power ſeemingly ſituated in every particle of the body. In conſequence of this principle, the body firſt ſwells, then burſts, flies off in vapour, and its particles fall aſunder from each other. The action of the putrefactive proceſs, then, is analogous to that of fire, ſince theſe are the very properties of fire, and the very effects which follow the action of fire upon any combuſtible body. It is therefore exceedingly probable, that the agent in the air, which we have all along conſidered as the cauſe of putrefaction, is no other than fire itſelf; that is, the ethereal fluid expanding itſelf everywhere, as from a centre to a circumference. The force of the fluid, indeed, is much leſs in putrefaction than in actual ignition; and therefore the effects alſo take place in a much ſmaller degree, and require a much longer time: nevertheleſs, the ſame circumſtances that are neceſſary for keeping up the action of fire, are alſo neceſſary for keeping up the putrefactive proceſs. One of theſe is a free acceſs of air, yet without too violent a blaſt; for as fire cannot burn without air, neither can it endure too much of it: thus a candle goes out if put under a receiver, and the air exhauſted; and it will do the ſame if we blow violently upon it. In like manner, putrefaction requires a certain quantity of air, much leſs indeed than fire: and as it requires leſs to ſupport it, ſo it can alſo endure much leſs air than fire; for a ſtream of air which would not put out a fire, will effectually prevent putrefaction. The cauſe of this in both is the ſame. Fire cannot burn becauſe the vapour is carried off too faſt; and thus the latent heat, which ought to ſupport the flame §, is entirely diſſipated. In like manner putrefaction is as certainly attended with an

§ See the article Flame.

an emiffion of azotic gas as fire is with an an emiffion of flame. Thefe gafes contain a great quantity of latent heat ‡, or of the expanfive principle already mentioned; and if thefe are carried off with greater rapidity than the heat of the atmofphere can produce them, the confequence muft be, that an oppofite principle to that which produces putrefaction, namely, a principle of cold, or condenfation, inftead of expanfion, muft take place, and the body cannot putrefy. That this muft be the cafe, is evident from the property which all evaporations have of producing cold ‖; and it is well known that a brifk current of air promotes evaporation to a great degree. Hence alfo the reafon is evident why bodies are preferved uncorrupted by cold; for thus the action of the expanfive principle is totally overcome and fufpended, fo that none of its effects can be perceived.

Thus we may fee, that one reafon why an animal body does not putrefy while alive, is its ventilation, as we may call it, by refpiration; and another is, the continual acceffion of new particles, lefs difpofed to putrefy than itfelf, by the food and drink which is conftantly taken in. But if either of thefe ways of preventing the commencement of this procefs are omitted, then putrefaction will take place as well in a living as in a dead body. Of the truth of this laft fact we have innumerable inftances. When air is infected with the putrid effluvia of marfhes, and thus the natural effluvia are not carried off from the human body, but, on the contrary, fome enter into it which are not natural to it, the moft putrid difeafes are produced. The fame thing happens from the putrid effluvia of dead bodies. Of this we have a remarkable inftance in the fever which took place in Germany in the war of 1755: one reafon of which is faid to have been an infection of the air by the vaft numbers of people killed in battle, to which was added a calm in the atmofphere for a long time; the putrid effluvia being by this prevented from flying off *. When Mr Holwell with 145 others were imprifoned in the black-hole at Calcutta, after paffing a night in that difmal habitation, he found himfelf in a high putrid fever. When failors in long voyages are obliged to feed upon putrid aliments; when, thro' ftormy weather, they are much expofed to wet; in the one cafe the putrefcent effluvia being kept from flying off, and in the other a greater quantity being thrown into the body than what it naturally contains, the fcurvy, malignant fevers, &c. make their appearance (A). Neither can thefe difeafes be removed without removing every one of the caufes juft now mentioned: for as putrid difeafes will be the confequence of confined air, naftinefs, &c. though the provifions be ever fo good; fo, on the other hand, if the provifions be bad, the beft air, and moft exact cleanlinefs, nay, the beft medicines in the world, will be of no fervice; as hath been often obferved in the fcurvy.

From this account of the nature, caufe, and method of preventing putrefaction by means of a current of air, we may eafily fee the reafon why it does not take place in fome other cafes alfo. Bodies will not putrefy *in vacuo*, becaufe there the atmofphere has not accefs to impart its elaftic principle; and though in the vacuum itfelf the principle we fpeak of does undoubtedly exift, yet its action there is by far too weak to decompofe the ftructure of an animal body. In extreme cold, the reafon why putrefaction does not take place has been already fhown. If the heat is extremely great, the procefs of ignition or burning takes place inftead of putrefaction. If the body is very dry, putrefaction cannot take place, becaufe the texture is too firm to be decompofed by the weak action of the elaftic principle. Putrefaction may alfo be prevented by the addition of certain fubftances; but they are all of them fuch as either harden the texture of the body, and thus render it proof againft the action of the elaftic fluid, or, by diffolving its texture entirely, bring it into a ftate fimilar to what it would be brought by

(A) This aeriform fluid, which is exhaled from animal bodies in a ftate of putrefaction, acts at certain times more powerfully than at others, and is indeed in one ftage of the procefs infinitely more noxious than any other elaftic fluid yet difcovered. In the Gentleman's Magazine for Auguft 1788, Dr St John, informs us, that he knew a gentleman who, by flightly touching the inteftines of a human body beginning to liberate this corrofive gas, was affected with a violent inflammation, which in a very fhort fpace of time extended up almoft the entire length of his arm, producing an extenfive ulcer of the moft foul and frightful appearance, which continued for feveral months, and reduced him to a miferable ftate of emaciation. The fame writer mentions a celebrated profeffor who was attacked with a violent inflammation of the nerves and fauces, from which he with difficulty recovered, merely by ftooping for an inftant over a body which was beginning to give forth this deleterious fluid. Hence he infers, that the fame gas modified or mixed, or united with others, may be the occafion of the plague, which has fo often threatened to annihilate the human fpecies. It is happy, however, for mankind that this particular ftage of putrefaction continues but for a few hours; and, what may appear very remarkable, this deftructive gas is not very difagreeable in fmell, and has nothing of that abominable and loathfome fetor produced by dead bodies in a lefs dangerous ftate of corruption; but has a certain fmell totally peculiar to itfelf, by which it may be inftantly difcovered by any one that ever fmelled it before. This is an object very worthy the attention of phyficians: it is both extremely interefting, and very little known; but at the fame time it is a ftudy in the higheft degree unpleafant, from the deteftable fmell and naftinefs which attend the putrefaction of animal bodies; and a man muft be armed with uncommon philanthropy and refolution to attempt it.

Dr St John thinks it probable that there is a rapid fixation of the bafis of vital air in dead bodies at a certain ftate of putrefaction, on account of the luminous appearance which they fometimes make, and which exifts but for a few hours: but whether this luminous appearance takes place in every body, or whether it precedes or follows the exhalations of the corrofive gas above-mentioned, he had not, when he wrote his paper, been able to difcover.

Putrefaction.

by the utmoſt power of putrefaction, ſo that the proceſs cannot then take place. Thus various kinds of ſalts and acids harden the texture of animal ſubſtances, and thus are ſucceſsfully uſed as antiſeptics. The ſame thing may be ſaid of ardent ſpirits; while oils and gums of various kinds prove antiſeptic by a total excluſion of air, which is neceſſary in ſome degree for carrying on the proceſs of putrefaction. Many vegetables, by the aſtringent qualities they poſſeſs, harden the texture of animal ſubſtances, and thus prove powerfully antiſeptic; while, on the other hand, fixed alkaline ſalts, quicklime, and cauſtic volatile alkali, though they prevent putrefaction, yet they do it by diſſolving the ſubſtances in ſuch a manner that putrefaction could do no more though it had exerted its utmoſt force. There is only one other antiſeptic ſubſtance whoſe effects deſerve to be conſidered, and that is ſugar. This, tho' neither acid nor alkaline, is yet one of the moſt effectual means of preventing putrefaction: and this ſeems to be owing to its great tendency to run into the vinous fermentation, which is totally inconſiſtent with that of putrefaction; and this tendency is ſo great, that it can ſcarce be counteracted by the tendency of animal ſubſtances to putrefy in any circumſtances whatever.

Some kinds of air are remarkably antiſeptic, though this ſubject has not been ſo fully inquired into as could be wiſhed. The moſt powerful of them in this reſpect is the nitrous air; next to it, is fixed air; but the powers of the other airs are not ſo well known. It is probable that the antiſeptic properties of fixed and nitrous air, are owing to their quality of extinguiſhing fire, or at leaſt that the principle is the ſame; but, till the nature of theſe two kinds of air are better known, little can be ſaid with certainty on the ſubject.

Sir John Pringle has made experiments to determine the powers of certain ſubſtances to promote or to prevent putrefaction. From theſe experiments he has formed the following Table, ſhowing the relative antiſeptic powers of the ſaline ſubſtances mentioned. Having found that two drams of beef put in a phial with two ounces of water, and placed in a heat equal to 90° of Fahrenheit's thermometer, became putrid in 14 hours, and that 60 grains of ſea-ſalt preſerved a ſimilar mixture of beef and water more than 30 hours, he made the antiſeptic power of the ſea-ſalt a ſtandard, to which he compared the powers of the other ſalts. The algebraic character + ſignifies, that the ſubſtance to which it is annexed had a greater antiſeptic power than is expreſſed by the numbers:

Sea-ſalt, or the ſtandard	1
Sal-gem	1+
Vitriolated tartar	2
Spiritus Mindereri	2
Soluble tartar	2
Sal diureticus	2+
Crude ſal ammoniac	3
Saline mixture	3
Nitre	4+
Salt of hartſhorn	4+
Salt of wormwood	4+
Borax	12
Salt of amber	20
Alum	30

N. B. The quantities of ſpiritus Mindereri and of the ſaline mixture were ſuch, that each of them contained as much alkaline ſalt as the other neutral ſalts.

Myrrh, aloes, aſafœtida, and terra Japonica, were found to have an antiſeptic power 30 times greater than the ſtandard. Gum ammoniacum and ſagapenum ſhowed little antiſeptic power.

Of all reſinous ſubſtances, camphor was found to reſiſt putrefaction moſt powerfully. Sir John Pringle believes that its antiſeptic power is 300 times greater than that of ſea-ſalt.

Chamomile flowers, Virginian ſnake-root, pepper, ginger, ſaffron, contrayerva root, and galls, were found to be 12 times more antiſeptic than ſea-ſalt.

Infuſions of large quantities of mint, angelica, ground-ivy, green tea, red-roſes, common wormwood, muſtard, and horſe-radiſh, and alſo decoctions of poppy-heads, were more antiſeptic than ſea-ſalt.

Decoctions of wheat, barley, and other farinaceous grains, checked the putrefaction by becoming ſour.

Chalk, and other abſorbent powders, accelerated the putrefaction, and reſolved meat into a perfect mucus. The ſame powders prevented an infuſion of farinaceous grains from becoming mucilaginous and ſour.

One dram of ſea-ſalt was found to preſerve two drams of freſh beef in two ounces of water, above 30 hours, uncorrupted, in a heat equal to that of the human body, or above 20 hours longer than meat is preſerved in water without ſalt: but half a dram of ſalt did not preſerve it more than two hours longer than pure water. Twenty-five grains of ſalt had little or no antiſeptic quality. Twenty grains, 15 grains, but eſpecially 10 grains only of ſea-ſalt, were found to accelerate and heighten the putrefaction of two drams of fleſh.— Theſe ſmall quantities of ſea-ſalt did alſo ſoften the fleſh more than pure water.

The ſame learned and ingenious phyſician made experiments to diſcover the effects of mixing vegetable with animal matters.

Two drams of raw beef, as much bread, and an ounce of water, being beat to the conſiſtence of pap, and expoſed to 90° of heat according to Fahrenheit's thermometer, began to ferment in a few hours, and continued in fermentation during two days. When it began to ferment and ſwell, the putrefaction had begun; and in a few hours afterwards, the ſmell was offenſive. Next day the putrid ſmell ceaſed, and an acid taſte and ſmell ſucceeded. Freſh alimentary vegetables, as ſpinach, aſparagus, ſcurvy-graſs, produced ſimilar effects as bread on fleſh, but in a weaker degree. From ſeveral other experiments he found, that animal ſubſtances excite the fermentation of vegetable ſubſtances, and that the latter ſubſtances correct the putreſcency of the former.

By adding ſaliva to a ſimilar mixture of fleſh, bread, and water, the fermentation was retarded, moderated, but rendered of twice the uſual duration, and the acid produced at laſt was weaker than when no ſaliva was uſed.

By adding an oily ſubſtance to the common mixture of fleſh, bread, and water, a ſtronger fermentation was produced, which could not be moderated by the quantity of ſaliva uſed in the former experiment, till ſome fixed alkaline ſalt was added; which ſalt was found, without ſaliva, to ſtop ſuddenly very high fermentations.

He did not find that ſmall quantities of the following ſalts,

falts, fal ammoniac, nitre, vitriolated tartar, fal diureticus, falt of hartfhorn, falt of wormwood, were feptic, as fmall quantities of fea-falt were.

Sugar was found to refift putrefaction at firft, as other falts do, and alfo to check the putrefaction after it had begun by its own fermentative quality, like bread and other fermentative vegetables.

Lime-water made fome fmall refiftance to putrefaction.

Port-wine, fmall-beer, infufions of bitter vegetables, of bark, and the juice of antifcorbutic plants, retarded the fermentation of mixtures of flefh and bread. But an unftrained decoction of bark confiderably increafed that fermentation.

Crabs-eyes accelerated and increafed the fermentation of a mixture of flefh and bread.

Lime-water neither retarded nor haftened the fermentation of fuch a mixture: but when the fermentation ceafed, the liquor was neither putrid nor acid, but fmelt agreeably.

Flefh pounded in a mortar was found to ferment fooner than that which had not been bruifed.

The tough inflammatory cruft of blood was found to be moft putrefcent; next to which the craffamentum, or red coagulated mafs; and laftly the ferum.

Dr Macbride's experiments confirm many of thofe above related, efpecially thofe which fhow that the fermentation of vegetable fubftances is increafed by a mixture of animal or putrefcent matter; that the putrefcency of the latter is corrected by the fermentative quality of the former; and that the putrefaction and fermentation of mixtures of animal and vegetable fubftances were accelerated by additions of abforbent earths and of Peruvian bark. He alfo found, that although unburnt calcareous earths were feptic, quicklime and lime-water prevented putrefaction, but that they deftroyed or diffolved the texture of flefh.

The experiments of the author of the *Effai pour fervir à l'Hiftoire de la Putrefaction*, fhow that metallic falts, refinous powders, extracts of bark, and opium, are very powerfully antifeptic, and that falts with earthy bafes are lefs antifeptic than any other falts.

PUTTOCK-SHROUDS. See *Puttock-Shrouds*.

PUTTY, in its popular fenfe, is a kind of pafte compounded of whiting and lintfeed oil, beaten together to the confiftence of a thick dough.

It is ufed by glaziers for the faftening in the fquares of glafs in fafh-windows, and by painters for ftopping up the crevices and clefts in timber and wainfcots, &c.

PUTTY fometimes alfo denotes the powder of calcined tin, ufed in polifhing and giving the laft glofs to works of iron and fteel.

TERRA PUZZULANA, or POZZOLANA, is a greyifh kind of earth ufed in Italy for building under water. The beft is found about Puteoli, Baiæ, and Cumæ, in the kingdom of Naples, from the firft of which places it derives its name. It is a volcanic product, compofed of heterogeneous fubftances, thrown out from the burning mouths of volcanoes in the form of afhes; fometimes in fuch large quantities, and with fo great violence, that whole provinces have been covered with it at a confiderable diftance. In the year 79 of the common era, the cities of Herculaneum, Pompeia, and Stabia, although at the diftance of many miles from Vefuvius, were, neverthelefs, buried under the matters of thefe dreadful eruptions; as Bergman relates in his *Treatife of the Volcanic Products*. This volcanic earth is of a grey, brown, or blackifh colour; of a loofe, granular, or dufty and rough, porous or fpongy texture, refembling a clay hardened by fire, and then reduced to a grofs powder. It contains various heterogeneous fubftances mixed with it. Its fpecific gravity is from 2500 to 2800; and it is, in fome degree, magnetic: it fcarcely effervefces with acids, though partially foluble in them. It eafily melts *per fe*; but its moft diftinguifhing property is, that it hardens very fuddenly when mixed with $\frac{1}{4}$ of its weight of lime and water; and forms a cement, which is more durable in water than any other.

According to Bergman's Analyfis, 100 parts of it contain from 55 to 60 of filiceous earth, 20 of argillaceous, five or fix of calcareous, and from 15 to 20 of iron. Its effects, however, in cement may perhaps depend only on the iron which has been reduced into a particular fubftance by means of fubterraneous fires; evident figns of which are obfervable in the places where it is obtained. If the flate in Henneberg, or Kennekulle in the province of Weftergottland, fhould happen to get fire, the uppermoft ftratum, which now confifts of a mixture of iron and different kinds of rocks, called *graberg* in the account given of them, they might perhaps be changed partly into flag and partly into *terra puzzolana*.

It is evidently a martial argillaceous marl, that has fuffered a moderate heat. Its hardening power arifes from the dry ftate of the half-baked argillaceous particles, which makes them imbibe water very rapidly, and thus accelerates the deficcation of the calcareous part; and alfo from the quantity and femiphlogifticated ftate of the iron contained in it. It is found not only in Italy but in France, in the provinces of Auvergne and Limoges; and alfo in England and elfewhere.

PUZZUOLI. See PUTEOLI.

PYANEPSIA, in antiquity, an Athenian feftival celebrated on the feventh day of the month *Pyanepfion*; which, according to the generality of critics, was the fame with our September.

Plutarch refers the inftitution of this feaft to Thefeus, who, after the funeral of his father, on this day paid his vows to Apollo, becaufe the youths who returned with him fafe from Crete then made their entry into the city. On this occafion, thefe young men putting all that was left of their provifions into one kettle, feafted together on it, and made great rejoicing. Hence was derived the cuftom of boiling pulfe on this feftival. The Athenians likewife carried about an olive branch, bound about with wool, and crowned with all forts of firft-fruits, to fignify that fcarcity and barrennefs were ceafed, finging in proceffion a fong. And when the folemnity was over, it was ufual to erect the olive-branch before their doors, as a prefervative againft fcarcity and want.

PYCNOSTYLE, in the ancient architecture, is a building where the columns ftand very clofe to each other; only one diameter and a half of the column being allowed for the intercolumniations.

According to Mr Evelyn, the pycnoftyle chiefly belonged to the compofite order, and was ufed in the moft magnificent buildings; as at prefent in the periftyle at St Peter's at Rome, which confifts of near 300 columns;

lumns; and in such as yet remain of the ancients, among the ruins of Palmyra.

PYGARGUS, in ornithology, a species of FALCO.

PYGMALION, in fabulous history, a king of Cyprus, who, being disgusted at the dissolute lives of the women of his island, resolved to live in perpetual celibacy; but making a statue of ivory, he fell so passionately in love with it, that the high festival of Venus being come, he fell down before the altar of that goddess, and besought her to give him a wife like the statue he loved. At his return home, he embraced, as usual, his ivory form, when he perceived that it became sensible by degrees, and was at last a living maid, who found herself in her lover's arms the moment she saw the light. Venus blessed their union; and, at the end of nine months, she was delivered of a boy, who was named *Paphos*.

PYGMY, a person not exceeding a cubit in height. This appellation was given by the ancients to a fabulous nation inhabiting Thrace; who brought forth young at five years of age, and were old at eight: these were famous for the bloody war they waged with the cranes. As to this story, and for the natural history of the true pygmy, see SIMIA.

PYKAR, a broker in India, inferior to those called *dallals*, who transacts the business at first hand with the manufacturer, and sometimes carries goods about for sale.

PYKE, a watchman in India, employed as a guard at night. Likewise a footman or runner on business. They are generally armed with a spear.

PYLADES, a son of Strophius, king of Phocis, by one of the sisters of Agamemnon. He was educated together with his cousin Orestes, with whom he formed the most inviolable friendship, and whom he assisted to revenge the murder of Agamemnon, by assassinating Clytemnestra and Ægysthus. He also accompanied him in Taurica Chersonesus; and for his services Orestes rewarded him, by giving him his sister Electra in marriage. Pylades had by her two sons, Medon and Strophius. The friendship of Orestes and Pylades became proverbial.

PYLORUS, in anatomy, the under orifice of the stomach. See ANATOMY, n° 91.

PYLUS (anc. geog.), a town of Elis; its ruins to be seen on the road from Olympia to Elis, (Pausanias); situated between the mouths of the Peneus aud Sellees, near Mount Scollis, (Strabo.) Built by Pylas of Megara, and destroyed by Hercules, (Pausanias.)—Another Pylus in Triphylia, (Strabo); by which the Alpheus runs, (Pausanias); on the confines of Arcadia, and not in Arcadia itself, (id.)—A third in Messenia, (Strabo, Ptolemy); situated at the foot of Mount Ægaleus on the sea-coast, over-against the island Sphagea or Sphacteria: built by Pylas, and settled by a colony of Leleges from Megara; but thence expelled by Neleus and the Pelasgi, and therefore called *Nelea*, (Homer.) A sandy territory. The royal residence of Neleus, and of Nestor his son; the more ancient and more excellent Pylus; whence the proverb *Pylus ante Pylum*, (Aristophanes, Plutarch), used when we want to repress the arrogance and pride of any one: said to be afterwards called *Coryphasium*. It made a figure in the Peloponnesian war; for being rebuilt by the Athenians, it proved of great benefit to them for the space of 15 years, and of much annoyance to the Lacedemonians, (Thucydides). All the three *Pyli* were subject to Nestor, (Strabo.)

PYRAMID, in geometry, a solid standing on a triangular, square, or polygonal basis, and terminating in a point at the top; or, according to Euclid, it is a solid figure, consisting of several triangles, whose bases are all in the same plane, and have one common vertex.

Pyramids are sometimes used to preserve the memory of singular events, and sometimes to transmit to posterity the glory and magnificence of princes. But as they are esteemed a symbol of immortality, they are most commonly used as funeral monuments and temples to the gods. Such is that of Cestius at Rome; the pyramids of Dashur drawn by Pocock; and those other celebrated ones of Egypt, as famous for the enormity of their size as their antiquity. Of these the largest are the pyramids of *Geeza*, so called from a village of that name on the banks of the Nile, distant from them about 11 miles. The three which most attract the attention of travellers stand near one another on the west side of the river, almost opposite to Grand Cairo, and not far from the place where the ancient Memphis stood. They were visited by M. Savary, of whose description of them we shall here give an abstract.

He took his journey in the night-time, in order to get up to the top of the great one by sunrise. Having got within sight of the two great ones, while the full moon shone upon them, he informs us, that they appeared, at the distance of three leagues, like two points of rock crowned by the clouds.

It is in the rich territory which surrounds them that fable has placed the Elysian fields. The canals which intersect them are the Styx and Lethe.

"The aspects of the pyramids varied according to the circuits he made in the plain, and the position of the clouds displayed themselves more and more to view. At half past three in the morning we arrived (says he) at the foot of the greatest. We left our clothes at the gate of the passage which leads to the inside, and descended, carrying each of us a flambeau in his hand. Towards the bottom you must creep like serpents to get into the interior passage, which corresponds with the former. We mounted it on our knees, supporting ourselves with our hands against the sides. Without this precaution one runs the risk of slipping on the inclined plane, where the slight notches are insufficient to stop the foot, and one might fall to the bottom. Towards the middle we fired a pistol, the frightful noise of which, repeated in the cavities of this immense edifice, continued a long time, and awakened thousands of bats, which flying round us, struck against our hands and faces, and extinguished several of our wax candles. They are much larger than the European bats. Arrived above, we entered a great hall, the gate of which is very low. It is an oblong square, wholly composed of granite. Seven enormous stones extend from one wall to the other, and form the roof. A sarcophagus made of a single block of marble lies at one end of it. It is empty; and the lid of it has been wrenched off. Some pieces of earthen vases lie around it. Under this beautiful hall is a chamber not so large, where you find the entrance to a conduit filled with rubbish. After examining these caves, where daylight never penetrated, we descended the same way, taking care not to fall in-

to a well, which is on the left, and goes to the very foundations of the pyramid. Pliny makes mention of this well, and ſays it is 26 cubits deep. The internal air of this edifice never being renewed, is ſo hot and mephitic that one is almoſt ſuffocated. When we came out of it, we were dropping with ſweat, and pale as death. After refreſhing ourſelves with the external air, we loſt no time in aſcending the pyramid. It is compoſed of more than 200 layers of ſtone. They overlap each other in proportion to their elevation, which is from two to four feet. It is neceſſary to climb up all theſe enormous ſteps to reach the top. We undertook it at the north-eaſt angle, which is the leaſt damaged. It took us, however, half an hour with great pains and many efforts to effect it.

"The ſun was riſing, and we enjoyed a pure air, with a moſt delicious coolneſs. After admiring the proſpect around us, and engraving our names on the ſummit of the pyramid, we deſcended cautiouſly, for we had the abyſs before us. A piece of ſtone detaching itſelf under our feet or hands might have ſent us to the bottom.

"Arrived at the foot of the pyramid, we made the tour of it, contemplating it with a ſort of horror. When viewed cloſe, it ſeems to be made of maſſes of rocks; but at a hundred paces diſtance, the largeneſs of the ſtones is loſt in the immenſity of the whole, and they appear very ſmall.

"To determine its dimenſions is ſtill a problem. From the time of Herodotus to our days it has been meaſured by a great number of travellers and learned men, and their different calculations, far from clearing up doubts, have only increaſed the uncertainty. The following table will ſerve at leaſt to prove how difficult it is to come at the truth.

	Height of the great Pyramid.	*Width of one of its ſides.*
Ancients.		French Feet.
Herodotus	800	800
Strabo	625	600
Diodorus Siculus	600 and a fraction.	700
Pliny	-	708
Moderns.		
Le Bruyn	616	704
Proſper Alpinus	625	750
Thevenot	520	682
Niebuhr	440	710
Greaves	444	648

Number of layers of Stone which form it.

Greaves	207	layers.
Maillet	208	
Albert Liewenſtein	260	
Pococke	212	
Belon	250	
Thevenot	208	

"It appears that Meſſrs Greaves and Niebuhr have prodigiouſly deceived themſelves in meaſuring the perpendicular height of the great pyramid. All the travellers allow that it has at leaſt 200 layers of ſtone. Theſe layers are from two to four feet high. According to Pococke, they are from four feet and a half to four feet high, being not ſo high at the top as at the baſe. Proſper Alpinus informs us, that the elevation of the firſt layer is five feet, but it diminiſhes inſenſibly in proportion as one mounts. Thevenot mentions 208 ſteps of large ſtones, the thickneſs of which makes the height of them about two feet and a half one with another: He meaſured ſome of them more than three feet high. I have meaſured ſeveral of them which were more than three feet high, and I found none leſs than two; the leaſt height of them we can take as a medium therefore is two feet and a half, which, even according to Mr Greaves's calculation, who reckons 207 layers, would make 517 feet 6 inches perpendicular height. Meſſrs Greaves, Maillet, Thevenot, and Pococke, who only differ in the number of the layers from 207 to 212, all mounted by the north-eaſt angle, as the leaſt injured. I followed the ſame route, and counted only 208 ſteps. But if we reflect that the pyramid has been open on the ſide next the deſert, that the ſtones on that ſide have been thrown down, that the ſand which covers them has formed a conſiderable hill, we ſhall not be aſtoniſhed that Albert Liewenſtein, Belon, and Proſper Alpinus, who muſt have mounted by the ſouth-eaſt or ſouth-weſt angle, which are leſs expoſed to the ſands of Lybia, ſhould have found a greater number of ſteps: ſo that the calculation of theſe travellers, agreeing with that of Diodorus Siculus and Strabo, appears to be neareſt the true height of the pyramid taken at its natural baſe; whence we may conclude with reaſon that it is at leaſt 600 feet high. Indeed this is authenticated by a paſſage of Strabo. Theſe are his words: 'Towards the middle of the height of one of the ſides is a ſtone that may be raiſed up. It ſhuts an oblique paſſage which leads to a coffin placed in the centre of the pyramid.' This paſſage, open in our days, and which in the time of Strabo was towards the middle of one face of the pyramid, is at preſent only 100 feet from the baſe. So that the ruins of the covering of the pyramid, and of the ſtones brought from within, buried by the ſand, have formed a hill in this place 200 feet high. Pliny confirms this opinion. The great ſphynx was in his time upwards of 62 feet above the ſurface of the ground. Its whole body is at preſent buried under the ſand. Nothing more appears of it than the neck and head, which are 27 feet high. If even the ſphynx, though defended by the pyramids againſt the northerly winds, which bring torrents of ſand from Libya, be covered as high as 38 feet, what an immenſe quantity muſt have been heaped up to the northward of an edifice whoſe baſe is upwards of 700 feet long? It is to this we muſt attribute the prodigious difference between the accounts of the hiſtorians who have meaſured the great pyramid at diſtant periods, and at oppoſite angles. Herodotus, who ſaw it in the age neareſt to its foundation, when its true baſe was ſtill uncovered, makes it 800 feet ſquare. This opinion appears very probable. Pliny alſo ſays that it covered the ſpace of eight acres.

"Meſſrs Shaw, Thevenot, and the other travellers who pretend that this pyramid was never finiſhed, becauſe it is open and without coating, are in an error. It is only neceſſary to obſerve the remains of the mortar, with the ſplinters of white marble which are to be found in many

Pyramid.

many parts of the fteps, to fee that it has been coated. After reading attentively the defcription given of it by the ancients, every doubt vanifhes, and the truth is as clear as day-light. Herodotus tells us, 'The great pyramid was covered with polifhed ftones, perfectly well jointed, the fmalleft of which was 30 feet long. It was built in the form of fteps, on each of which were placed wooden machines to raife the ftones from one to another.' According to Diodorus, 'The great pyramid is built of ftones, very difficult of workmanfhip, but of an eternal duration. It is preferved to our days (towards the middle of the Auguftan age) without being in the leaft injured. The marble was brought from the quarries of Arabia.' This hiftorian thought that the whole building was compofed of ftones, fimilar to thofe of the coating, which were of very hard marble. Had there been fome pieces torn off, he would have perceived under that covering a calcareous ftone rather foft. Pliny fays that it 'is formed of ftones brought from the quarries of Arabia. It is not far from the village of Bufiris (which ftill exifts under the name of *Boufir)*, where thofe perfons refide who are fo fkilful as to climb up to the top.'

"This paffage fhows that Pliny, deceived by the appearance, was in the fame error with Diodorus Siculus. It demonftrates alfo that it was covered: for what difficulty would there have been for the inhabitants of Bufiris to fcale a building raifed by fteps? but it was really a prodigy for them to get up it when it formed a mountain, the four inclined planes of which prefented a furface covered with polifhed marble. It is indeed an inconteftable fact, that the great pyramid was coated. It is as certain too that it has been fhut, as Strabo gives us to underftand; and that by removing a ftone placed in the middle of one of the fides, one found a paffage which led to the tomb of the king. But I fhall leave Mr Maillet, who vifited it 40 times with all imaginable attention, the honour of relating the means employed to open it. I have examined the infide of it in two different journeys: twice I have mounted it: and I cannot help admiring the fagacity with which that author has developed the mechanifm of that aftonifhing edifice."

Our author next proceeds to give a particular defcription of the methods by which it is moft probable that the pyramids were clofed, and the immenfe labour requifite to open them; but as this defcription affords nothing very interefting, we fhall not infert it. Only we muft remark, that the final outlet to the workmen he fuppofes to have been the well at the entrance formerly mentioned. This well defcends towards the bottom of the pyramid by a line not quite perpendicular to the horizon, but flanting a little, in fuch a manner as to refemble the figure of the Hebrew letter Lamed. About 60 feet from the aperture there is a fquare window in this paffage, from whence we enter a fmall grotto hewn out of the mountain; which in this place is not a folid ftone, but a kind of gravel concreted together. The grotto extends about 15 feet from eaft to weft, where there is another groove hollowed likewife, but almoft perpendicular. It is two feet four inches wide by two and an half in height. It defcends through a fpace of 123 feet, after which we meet with nothing but fand and ftones. M. Savary is convinced that the only ufe of this paffage was to ferve as a retreat for the labourers who conftructed the pyramid; and of this he looks upon the flope of the conduit, its winding road, its fmallnefs, and its depth, to be certain proofs. The way out of it he fuppofes to have been formed by a paffage over which hung a row of ftones, which they had difcovered the fecret of fufpending, and which falling down into the paffage by the means of fome fpring they fet in motion, fhut up the entrance for ever, as foon as the workmen were withdrawn from the pyramid.

It feems to be an unqueftionable fact, that this pyramid was a maufoleum of one of the kings of Egypt, and it is very probable that all the reft anfwered fimilar purpofes. We do not, however, think that this was their primary ufe or the original defign of their builders. Mr Bryant is of opinion that they were temples erected in honour of the Deity; and a very ingenious writer in the Gentleman's Magazine for June 1794 has done much to prove that they were altars dedicated to the fun, the firft and greateft god in every pagan kalendar.

"Our Englifh word pyramid (fays he) is directly derived from the Latin *pyramis*, and mediately from the Greek πυραμις; all denoting the fame mathematical figure. The original of the whole feems to be the Egyptian word *pyramoua*, which, we are told by Oriental fcholars, fignifies light, or a ray of light. From this Coptic vocable the word πυρ in Greek, fignifying fire, is probably defcended; as the flames of fire affume that conical or pyramidal form which the folar rays commonly difplay; and as it is natural for the mind to diftinguifh its objects rather by their external qualities, and thofe obvious and interefting appearances which they exhibit to the fenfes, than by their conftituent and infeparable properties.

"The ancient Egyptians feem to have penetrated very far into the myfteries of nature; and although their fuperftition appears at firft fight to be extremely grofs and abfurd, yet it is very probable that their deities were only emblematical perfonages, reprefenting by fenfible images the grand effects or prefiding principles which they fuppofed to exift in the univerfe. Thus the moon was called *Ifis*, and the fun *Ofiris*; and to the honour of this laft deity, from whofe vifible influence and creative energy all things feem to fpring into exiftence, it is not improbable that the Egyptians erected thofe ftupendous monuments, and dedicated them to him as temples or altars. It was natural to build them in that fhape which the rays of the fun difplay when difcovered to the eye, and which they obferved to be the fame in terreftrial flame, becaufe this circumftance was combined in their imaginations with the attribute which they adored. If they were temples dedicated to the fun, it feems a natural confequence that they fhould likewife be places of fepulture for kings and illuftrious men, as the fpace which they covered would be confidered as confecrated ground. This hypothefis is common, and is not contradicted by the prefent reafoning. But, confidering them as altars, and as moft travellers agree that they were never finifhed, but terminate in a fquare horizontal furface, it would not be refining too much to venture an affertion that, in great and folemn acts of adoration, the Egyptians conftructed fires, the flames of which fhould terminate in the vertex of the pyramid, and fo complete that emanation of their deity which they admired and adored. As far, therefore, as we are juftified in forming any conclufion on fo dark a fubject, we

we may venture to say, that the Egyptian pyramids were temples or altars dedicated to the sun, as the material representative of that invisible power which creates, governs, and pervades, the whole system of nature."

This reasoning has great force; and it certainly receives additional strength from the undoubted fact, that the first statues for idolatrous worship were erected on the tops of mountains, and of a pyramidal or conical form. (See POLYTHEISM, n° 13 and 21.) It is likewise corroborated by other circumstances discovered by the members of the Asiatic Society. In the second volume of their transactions we have an account of several large statues of the gods SEEVA and MCHEDEO, all of a conical or pyramidal figure; but it has been shown in the article already referred to, that the idolatry of Hindostan was probably of Egyptian original.

It is not known in Europe when the pyramids were built; but we have reason to expect a history of them soon from Shanscrit records examined by Mr Wilford lieutenant of engineers. It is as little known at what time, or from what motive, the great pyramid was opened. Some think it was done by one of the khalifs about the beginning of the eighth century, in expectation of finding a great treasure; but all he met with was the king's body, with some golden idols which had been buried along with it.—By others it is supposed to have been done by the celebrated Harun Al Basakid khalif of Bagdad; but all are agreed that this pyramid was opened in the time of the Arabs. The second pyramid has likewise been opened; and an attempt was made not long ago upon the third by one of the Beys of Cairo: but after removing a number of stones at a considerable expence, he thought proper to desist from the enterprize.—Mr Bryant is of opinion that the pyramids, at least the three great ones, are not artificial structures of stone and mortar, but solid rocks cut into a pyramidal shape, and afterwards cased with stone; and to this we find that Mr Bruce likewise assents. The reason given for this opinion is, that the passages within it seem rather to answer to the natural cavities and rents in rocks than to the artificial ones in buildings. The opinion, however, we think sufficiently confuted by Savary and Maillet: and, as an acute critic observes, it is in itself as improbable as that the caverns inhabited by the *Troglodytes* were dug by the hands of man. See TROGLODYTES.

On the east side of the second pyramid is the sphynx, an enormous mass of one solid stone, but so buried in the sand that only the top of the back is visible, which is 100 feet long. Its head rises, as we have seen, 27 feet above the sand; and its face has been disfigured by the Arabs, who hold all representations of men and living animals in detestation. Other travellers say that this sphynx is a huge mishapen rock, by no means worthy of the attention which has been bestowed upon it.

In the desert of Saccara there are a great number of pyramids, which, in Mr Bruce's opinion, are composed of clay. They terminate in what the inhabitants call a *dagiour*, or *false pyramid*, about two miles from the Nile, between Suf and Woodan. This is no other than a hill cut into the shape of a pyramid, or naturally so formed, for a considerable height; on the top of which is a pyramidal building of brick terminating in a point, and having its basis so exactly adapted to the top of the hill, that at a distance the difference cannot be perceived; especially as the face of the stone resembles very nearly the clay of which the pyramids of the Saccara are composed.

PYRAMIDALES, in anatomy, one of the muscles of the abdomen. See ANATOMY, *Table of the Muscles*.

PYRENEAN MOUNTAINS, or PYRENEES, are the mountains which divide France from Spain, and are the most celebrated in Europe, except the Alps. They reach from the Mediterranean Sea as far as the ocean, and are about 212 miles in length. They have different names, according to the different places wherein they stand. Some think they are as high as the Alps; but the passages over them are not so difficult, whatever some travellers may think who have not crossed the former.

BANKSIA PYRIFORMIS, in botany, is a species of BANKSIA, which see. It was unknown to Linnæus; and Gaertner, who has mentioned it, gives no specific character of it. It has solitary flowers, ovate downy capsules, and lance-shaped entire smooth leaves. The capsules larger than in any other known species. See *White's Journal of a Voyage to New South Wales*, p. 221—225.

PYRITES, a genus of inflammable substances composed of sulphur, which has dissolved or saturated itself with metals. Thus there are many kinds of pyrites; as of gold, arsenic, iron, &c. It is also the principal ore of sulphur; particularly that called *martial pyrites*, *copperas-stone*, or *marcasite*. This is very common, containing a quantity of sulphur in proportion to the iron; and, when thoroughly inflamed, burns by itself. It is either of a compact texture, steel-grained, coarse-grained, or crystallised. In this last form, it shoots mostly into cube and octohedral figures, though it is met with also in innumerable other forms.

The liver-coloured marcasite has an appearance between that of the preceding and the blue copper-ore. The iron predominates in this kind, so that it is less fit than the other for extracting sulphur from it, or for the smelting of copper-ores. It is formed of a compact texture, coarse-grained, and steel-grained. See CHEMISTRY, n° 619 and 654; MINERALOGY, p. 109; and METALLURGY, p. 429.

PYRMONT, a town of Lippe in Germany, in the circle of Westphalia, and capital of a country of the same name. It has a castle, kept by a governor, who is under the counts of Waldeck. At a small distance from hence there are mineral waters, which are much esteemed. The Protestants have here the free exercise of their religion. It is seated on the confines of the duchy of Brunswick, 40 miles south-west of Hanover. E. Long. 9. 0. N. Lat. 52. 0.

PYROLA, in botany: A genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the 18th order, *Bicornes*. The calyx is quinquepartite; there are five petals; the capsule is quinquelocular, opening at the angles.

PYROMANCY, a kind of divination by means of fire. See DIVINATON, n° 6.

PYROMETER, an instrument for measuring the expansion of bodies by heat. See CHEMISTRY, n° 103. Muschenbroeck, who was the original inventor of this machine, has given a table of the expansion of the different metals in the same degree of heat. Having prepared cylindric rods of iron, steel, copper, brass, tin,

 and

Pyrometer. and lead, he expofed them firft to a pyrometer with one flame in the middle; then with two flames; and fucceffively to one with three, four, and five flames. But previous to this trial, he took care to cool them equally, by expofing them fome time upon the fame ftone, when it began to freeze, and Fahrenheit's thermometer was at 32 degrees. The effects of which experiment are digefted in the following table, where the degrees of expanfion are marked in parts equal to the $\frac{1}{12500}$ part of an inch.

Expanfion of	Iron.	Steel.	Copper.	Brafs.	Tin.	Lead.
By one flame	80	85	89	110	153	155
By two flames placed clofe together.	117	123	115	220		274
By two flames 2½ inches diftant.	109	94	92	141	219	263
By three flames placed clofe together.	142	168	193	275		
By four flames placed clofe together.	211	270	270	361		
By five flames.	230	310	310	377		

It is to be obferved of tin, that it will eafily melt when heated by two flames placed together. Lead commonly melts with three flames placed together, efpecially if they burn long.

From thefe experiments, it appears at firft view that iron is the leaft rarefied of any of thefe metals, whether it be heated by one or more flames; and therefore is moft proper for making machines or inftruments which we would have free from any alterations by heat or cold, as the rods of pendulums for clocks, &c. So likewife the meafures of yards or feet fhould be made of iron, that their length may be as nearly as poffible the fame fummer and winter.

The expanfion of lead and tin, by only one flame, is nearly the fame; that is, almoft double of the expanfion of iron. It is likewife obfervable, that the flames placed together, caufe a greater rarefaction than when they have a fenfible interval between them; iron in the former cafe, being expanded 117 degrees, and only 109 in the latter; the reafon of which difference is obvious.

By comparing the expanfions of the fame metal produced by one, two, three, or more flames, it appears that two flames do not caufe double the expanfion of one, nor three flames three times that expanfion, but always lefs; and thefe expanfions differ fo much the more from the ratio of the number of flames as there are more flames acting at the fame time.

It is alfo obfervable, that metals are not expanded equally at the time of their melting, but fome more fome lefs. Thus tin began to run when rarefied 219 degrees; whereas brafs was expanded 377 degrees, and yet was far from melting.

Mr Ellicot found, upon a medium, that the expanfion of bars of different metals, as nearly of the fame dimenfions as poffible, by the fame degree of heat, were as follow:

Gold,	Silver,	Brafs,	Copper,	Iron,	Steel,	Lead,
73	103	95	89	60	56	149

The great difference between the expanfions of iron and brafs has been applied with good fuccefs to remedy the irregularities in pendulums arifing from heat. See PENDULUM.

Mr Graham ufed to meafure the minute alterations, in length, of metal bars, by advancing the point of a micrometer-fcrew, till it fenfibly ftopped againft the end of the bar to be meafured. This fcrew, being fmall and very lightly hung, was capable of agreement within the three or four-thoufandth part of an inch. On this general principle Mr Smeaton contrived his pyrometer, in which the meafures are determined by the contact of a piece of metal with the point of a micrometer-fcrew.

The following table fhows how much a foot in length of each metal grows longer by an increafe of heat, correfponding to 180° of Fahrenheit's thermometer, or to the difference between freezing and boiling water, expreffed in fuch parts of which the unit is equal to the 10,000th part of an inch.

1.	White-glafs barometer tube,	100
2.	Martial regulus of antimony,	130
3.	Bliftered fteel,	138
4.	Hard fteel,	147
5.	Iron,	151
6.	Bifmuth,	167
7.	Copper hammered,	204
8.	Copper eight parts, with tin one,	218
9.	Caft brafs,	225
10.	Brafs fixteen parts, with tin one,	229
11.	Brafs-wire,	232
12.	Speculum metal,	232
13.	Spelter folder, viz. brafs two parts, zinc one,	247
14.	Fine pewter,	274
15.	Grain tin,	298
16.	Soft folder, viz. lead two, tin one,	301
17.	Zinc eight parts, with tin one, a little hammered,	323
18.	Lead,	344
19.	Zinc or fpelter,	353
20.	Zinc hammered half an inch per foot,	373

We fhall clofe this article with a brief defcription of a pyrometer lately invented by M. De Luc, in confequence of a hint fuggefted to him by Mr Ramfden. The bafis of this inftrument is a rectangular piece of deal-board two feet and a half long, 15 inches broad, and one inch and a half thick; and to this all the other parts are fixed. This is mounted in the manner of a table, with four deal legs, each a foot long and an inch and a half fquare, well fitted near its four angles, and kept together at the other ends by four firm crofs-pieces. This fmall table is fufpended by a hook to a ftand; the board being in a vertical fituation in the direction of its grain, and bearing its legs forward in fuch a manner as that the crofs-pieces which join them may form a frame, placed vertically facing the obferver. This frame fuftains a microfcope, which is firmly fixed in another frame that moves in the former by means of grooves, but with a very confiderable degree of tightnefs;

meter, Pyrophorus. ness; the friction of which may be increased by the pressure of four screws. The inner sliding frame, which is likewise of deal, keeps the tube of the microscope in a horizontal position, and in great part without the frame, insomuch that the end which carries the lens is but little within the space between the frame and the board. This microscope is constructed in such a manner as that the object observed may be an inch distant from the lens; and it has a wire which is situated in the focus of the glasses, in which the objects appear reversed. At the top of the apparatus there is a piece of deal, an inch and a half thick and two inches broad, laid in a horizontal direction from the board to the top of the frame. To this piece the rods of the different substances, whose expansion by heat is to be measured, are suspended: one end of it slides into a socket, which is cut in the thickness of the board; and the other end, which rests upon the frame, meets there with a screw, which makes the piece move backward and forward, to bring the objects to the focus of the microscope. There is a cork very strongly driven through a hole boared vertically through this piece; and in another vertical hole made through the cork, the rods are fixed at the top; so that they hang only, and their dilatation is not counteracted by any pressure. In order to heat the rods, a cylindrical bottle of thin glass, about 21 inches high, and four inches in diameter, is placed in the inside of the machine, upon a stand independent of the rest of the apparatus. In this bottle the rods are suspended at a little less than an inch distance from one of the insides, in order to have them near the microscope. Into this bottle is poured water of different degrees of heat, which must be stirred about, by moving upwards and downwards, at one of the sides of the bottle, a little piece of wood, fastened horizontally at the end of a stick: in this water is hung a thermometer, the ball of which reaches to the middle of the height of the rods. During these operations the water rises to the cork, which thus determines the length of the heated part; the bottle is covered, to prevent the water from cooling too rapidly at the surface; and a thin case of brass prevents the vapour from fixing upon the piece of deal to which the rods are fixed.

PYROPHORUS, formed of πυρ, *fire*, and φερω, *I bear*, in chemistry, the name usually given to that substance called by some black phosphorus; a chemical preparation possessing the singular property of kindling spontaneously when exposed to the air. See CHEMISTRY, n° 1414.

This substance was accidentally discovered by M. Homberg, who prepared it of alum and human fæces. See PHOSPHORUS. It was apprehended, for a considerable time after the discovery, that human fæces were essential to the operation, till the youngest son of the great Lemeri found that honey, sugar, flour, and indeed any animal or vegetable matter, might be substituted instead of the human fæces; and since that time, M. De Sauvigny has shown that most vitriolic salts may be substituted for the alum; having added to the aluminous pyrophorus of Homberg two other classes of substances of this kind, viz. the metallic, or those made with the three vitriols of iron, copper, and zinc; and the neutral, or those composed of vitriolated tartar and Glauber's salt.

Mr Bewly prepares his pyrophorus in the following manner. "I fill (says he) half or three-fourths of the bowl of a tobacco-pipe with a mixture, consisting of two parts of alum, previously calcined in a red-heat, and of powdered charcoal and salt of tartar each one part; pressing the matter down slightly, and filling the remainder of the bowl with fine sand. As soon as the powder becomes hot, the sand lying over it is put into a state of ebullition, which generally continues several minutes. This appearance seems to proceed partly from the vitriolic acid in the alum leaving its earth, and expelling fixed air from the alkali; while another part of it is possibly converted into vitriolic acid air. This phenomenon is succeeded by the appearance of a blue sulphureous flame, proceeding from the combination of the same acid with what was formerly called the *phlogiston of the coal*, and which continues about ten minutes or a quarter of an hour. After it ceases, no other remarkable appearance presents itself. The matter is now to be kept in a red heat 20 minutes or half an hour; or it may continue there two hours longer, if the operator pleases, without any injury to the pyrophorus. The pipe being taken out of the fire, the matter is knocked out of it as soon as it becomes cool, and generally pretty soon afterwards takes fire spontaneously."

In another experiment, having added successively various and increasing quantities of fixed alkali to the salt heated as above, till the vitriolic acid contained in the mixture might be considered merely as an evanescent quantity, a pyrophorus was still produced on calcining it with charcoal as before. He also mixed equal parts of salt of tartar and vegetable or animal coal, or sometimes three parts of the former with two of the latter, and calcined them in the usual manner: and this composition, on being exposed to the air, generally kindled in half a minute or a minute; though, as it contained no sulphur, it did not burn with so much vivacity as the vitriolic pyrophori. This, which Mr Bewly calls the *alkaline pyrophorus*, differs in no circumstance from M. De Sauvigny's neutral pyrophori, except in its not containing that principle to which he ascribes their accension. However, lest it might be suspected that the salt of tartar which he employed might accidentally contain vitriolated tartar, or vitriolic acid, he repeated the experiment with tartar calcined by himself, as well as with nitre fixed or alkalised by deflagration with charcoal, and with iron filings; and in all these cases with the same result. By diversifying in a like manner M. De Sauvigny's experiments on the metallic pyrophori, Mr Bewly found that none of the three vitriols, heated with charcoal alone, in his usual method, could produce a pyrophorus. And thus he found that the addition of an alkaline salt to the composition, which was a part of M. De Sauvigny's process, was essential to its success.

Treating in the usual manner equal parts of calcined green vitriol and charcoal, the powder, which contained no sulphur nor hepar sulphuris, did not acquire any of the properties of a pyrophorus. The vitriolic acid seemed to have been entirely dissipated, having no base to detain it, when dislodged from the metallic earth. The charcoal and calx of iron left in this process were calcined again, together with some salt of tartar: and a pyrophorus was produced, which exhibited indications of its containing a scarce perceptible

 portion

Pyrophorus.

portion of hepar sulphuris. Thirty grains of crocus martis astringens were calcined with 15 grains of charcoal, and the same quantity of salt of tartar; and the mixture burnt spontaneously, though it contained no hepar sulphuris or vitriolic acid. Having by these experiments evinced that metallic pyrophori may be prepared without vitriolic acid, Mr Bewly proceeded to form an aluminous pyrophorus of the same kind. For this purpose he procured the earth of alum by a long and violent calcination; and examining a part of it, he found, by the usual tests, that it neither contained any sulphur, hepar sulphuris, nor alum undecompounded. This he considered as perfectly pure, though he afterwards found that it contained a small quantity of vitriolated tartar; and yet it repeatedly furnished a pyrophorus, as active as when alum itself is employed. From these and similar experiments, he infers, that the several kinds of pyrophori are not kindled by moisture, attracted by the vitriolic acid, as M. De Sauvigny has maintained; and his conclusion is farther confirmed by some experiments of Dr Priestley; from which it appears, that they are kindled in dry, nitrous, and what he calls dephlogisticated air.

M. Proust, cited by Mr Bewly, describes a variety of new pyrophori, which neither contain vitriolic acid, nor seem likely to owe their accension to the attraction of humidity from the air. These principally consist of a coaly matter simply divided by metallic or other earths; such are the sediment left on the filter in preparing Goulard's extract, various combinations of tartar or its acid, or the acetous acid, with metals, calcareous earth, &c.

Mr Bewly, having evinced the insufficiency of M. De Sauvigny's theory, and discovered that the pyrophori are not kindled by moisture, attracted (merely) by the vitriolic acid, directed his attention to the nitrous acid, which Dr Priestley has shown to be a constituent part of atmospherical air, as the probable agent in the production of this phenomenon. The strong affinity which this acid has with phlogiston, and the heat, and even flame, which it is known to produce with certain inflammable matters, manifested that it was equal to the effect; and having excluded the vitriolic acid from having any essential concern in this operation, he suggests, either that the pyrophorus is kindled by moisture attracted by some of the other ingredients which compose it; or that it has the power of decompounding atmospherical air, by suddenly attracting its nitrous acid, and thereby generating a heat sufficient to kindle the phlogistic matter contained in it. This idea appeared plausible, when he farther considered that Dr Priestley produced the purest respirable air with this same acid combined with other principles; and that this as well as common air is diminished, and probably in part decompounded, in a variety of phlogistic processes. This ingenious writer concludes, upon the whole, from the experiments he hath made, that the pyrophorus seems to owe its singular property to its being a combination of earth or alkali with phlogiston; the vitriolic acid, when present, only occasionally increasing or diminishing the effect, according to circumstances. In the process of calcination, the earth or alkaline principle is not merely mixed, but actually, though loosely, combined with the phlogistic principle of the coal; so that the pyrophorus, considering it in its most simple state, is only a perfectly dry phlogisticated alkali or earth. On these data, the phenomena may be explained in the two following methods; with respect particularly to the influence of moisture and heat upon the pyrophorus. Supposing either the alkaline or earthy principle to have a greater affinity to water than to the phlogiston with which either of them is united, they may, on being exposed to a moist atmosphere, attract the humidity, and thereby set the phlogistic principle at liberty; which may, in its turn, attract, and be ignited by, the supposed aerial acid; its strong affinity to which is well known:—or, if this hypothesis be rejected, the inflammable matter may be kindled, merely in consequence of the heat produced by the combination of the alkali, &c. with moisture.

Mr Keir gives the following description of a process for preparing a new pyrophorus which he has lately discovered: "I filled about five-sixths of the contents of a copper cylindrical box, which had a lid fitted to it, and which was three inches in diameter and two inches in depth, with saw-dust, which I pressed down; and I laid upon the saw-dust as much well-washed *plumbum corneum* as entirely filled the box, which I then covered with its lid. I placed the box on the coals of a chamber-fire, so that its bottom only should be in contact with the fuel, and I kept it on the fire till no more vapour seemed to issue at the joining of the lid. I then removed it from the fire; and while it was hot, I closed up the joining of the lid with sealing-wax, by which means the external air was excluded. After it had stood in the cold about ten hours, I opened the box; and the corneous lead, which was very white before the operation, was now rendered black by the vapour which had arisen from the saw-dust, and which was obliged to pass through the lead before it could escape. This black metallic mass was no sooner exposed to the air, than ignited sparks appeared, which spread more and more, while the lead was seen to revive in the form of minute globules, and the part which did not revive was changed into a yellow powder, or calx of lead. It is to be observed, that before I opened the box, I placed it at the side of the fire, in order to melt the sealing-wax, to enable me to separate the lid. It is possible that this small degree of heat may be necessary, or conducive, to the accension. I ought also to acquaint you, that the preparation of this pyrophorus requires nicer attention than that of any which I am acquainted with. For a small excess of heat will revive the lead, which will spoil the experiment. Also, if any air be admitted through the joints of the vessels employed, the kindling property will be prevented by the absorption of the air; which in this case is generally too gradual to produce inflammation. The metallic substance in this state of impregnation with inflammable matter, although not a pyrophorus, is an exceeding quick tinder. For when touched, however slightly, by an ignited body, it will instantly kindle, and the fire will spread over the whole piece, reviving the lead wherever it goes, and exhibiting a very beautiful example of metallic reduction, not unlike the familiar experiment of reviving the lead of a wafer containing minium at the flame of a candle; but with this difference, that the fire in the wafer requires to be kept up by flame; whereas in this metallic tinder it spreads and creeps spontaneously along without flame over the mass.

PYROTECHNY;

PYROTECHNY;

THE art of fire, or a ſcience which teaches the management and application of fire in ſeveral operations. See FIRE, FURNACE, CHEMISTRY, DISTILLATION, METALLURGY, &c.

But the term is more particularly uſed to denote the doctrine of artificial fire-works and fire-arms, teaching the ſtructure and uſe, 1. Of thoſe uſed in war, the attacking of fortifications, &c. for which ſee the articles FUSEE, GUN, GUNNERY, GUNPOWDER, MINE, &c.; and, 2. Of thoſe made for amuſement's ſake, as rockets, ſtars, ſerpents, &c. the preparation and conſtruction of which fall to be explained in the preſent article.

SECT. I. *Of Ingredients and Compoſitions.*

1. *Saltpetre.*

Saltpetre being the principal ingredient in fire-works, and a volatile body, by reaſon of its aqueous and aerial parts, is eaſily rarefied by fire; but not ſo ſoon when foul and groſs as when purified from its crude and earthy parts, which greatly retard its velocity: therefore, when any quantity of fire-works are to be made, it ſhould be examined; for if it is not well cleanſed, and of a good ſort, your works will not have their proper effect; neither will it agree with the ſtanding proportions of compoſitions. Therefore,

To refine it, put into a copper, or any other veſſel, 100 lb. of rough nitre with 14 gallons of clean water; let it boil gently half an hour, and as it boils take off the ſcum; then ſtir it, and before it ſettles put it into your filtering bags, which muſt be hung on a rack, with glazed earthen pans under them, in which muſt be ſticks laid acroſs for the cryſtals to adhere to: it muſt ſtand in the pans two or three days to ſhoot; then take out the cryſtals, and let them dry. The water that remains in the pans boil again an hour, and ſtrain it into the pans as before, and the ſaltpetre will be quite clear and tranſparent; if not, it wants more refining; to do which proceed as uſual, till it is well cleanſed of all its earthy parts.

N. B. Thoſe who do not chooſe to procure their ſaltpetre by the above method, may buy it ready done, which for fire-works in general will do.

To pulveriſe Saltpetre. Take a copper kettle, whoſe bottom muſt be ſpherical, and put into it 14 lb. of refined ſaltpetre, with 2 quarts or 5 pints of clean water: then put the kettle on a ſlow fire; and when the ſaltpetre is diſſolved, if any impurities ariſe, ſkim them off, and keep conſtantly ſtirring with two large ſpatulas, till all the water exhales; and when done enough, it will appear like white ſand, and as fine as flour; but if it ſhould boil too faſt, take the kettle off the fire, and ſet it on ſome wet ſand, which will prevent the nitre from ſticking to the kettle. When you have pulveriſed a quantity of ſaltpetre, be careful to keep it in a dry place.

To extract Saltpetre from damaged Gunpowder.—Have ſome filtering bags, hung on a rack, with glazed earthen pans under them, in the ſame manner as thoſe for refining ſaltpetre; then take any quantity of damaged powder, and put it into a copper, with as much clean water as will cover it: when it begins to boil, take off the ſcum; and after it has boiled a few minutes, ſtir it up: then take it out of the copper with a ſmall hand-kettle for that purpoſe, and put ſome into each bag, beginning at one end of the rack, ſo that by the time you have got to the laſt bag, the firſt will be ready for more. Continue thus till all the bags are full: then take the liquor out of the pans; which boil and filter, as before, two or three times, till the water run quite clear, which you muſt let ſtand in the pan ſome time, and the ſaltpetre will appear at top. To get the ſaltpetre entirely out of the powder, take the water from that already extracted, to which add ſome freſh and the dregs of the powder that remain in the bags, and put them in a veſſel, to ſtand as long as you pleaſe: and when you want to extract the nitre, you muſt proceed with this mixture as with the powder at firſt, by which means you will draw out all the ſaltpetre; but this proceſs muſt be boiled longer than the firſt.

2. *Sulphur, or Brimſtone.*

Sulphur is one of the principal ingredients in gunpowder, and almoſt in all compoſitions of fire-works; and therefore great care muſt be taken of its being good, and brought to the higheſt perfection. To know when ſulphur is good, you are to obſerve that it is of a high yellow; and if, when held in one's hand, it crackles and bounces, it is a ſign that it is freſh and good: but as the method of reducing brimſtone to a powder is very troubleſome, it is better to buy the flour ready made, which is done in large quantities, and in great perfection; though when a grand collection of fire-works are to be made, the ſtrongeſt and beſt ſulphur is the lump brimſtone ground in the manner directed in art. 8.

3. *Charcoal.*

Charcoal is a preſervative by which the ſaltpetre and the brimſtone are made into gunpowder, by preventing the ſulphur from ſuffocating the ſtrong and windy exhalation of the nitre. Charcoal for fire-works muſt always be ſoft and well burnt, which may be bought ready done.

4. *Gunpowder.*

See GUNPOWDER in the order of the alphabet. To grind or meal it, is directed in art. 8.

5. *Camphor.*

This may be had in the ſhops; and is of two kinds, differing in regard to the degree of their purity, and diſtinguiſhed by the name of *rough* and *refined*. Refined camphor muſt be choſen of a perfectly clean white colour, very bright and pellucid, of the ſame ſmell and taſte with the rough, but more acrid and pungent. It is ſo volatile, that merchants uſually incloſe it in lintſeed, that the viſcoſity of that grain may keep its particles together.

6. *Benjamin.*

This is a reſin found of different ſorts; and diſtinguiſhed by their colours, viz. yellow, grey, and brown; but the beſt is that which is eaſy to break, and full of white

Ingredients and Compositions.

white spots. It is one of the ingredients in odoriferous fire-works, when reduced to a fine flour; which may be done by putting into a deep and narrow earthen pot 3 or 4 oz. of benjamin grossly pounded; cover the pot with paper, which tie very close round the edge; then set the pot on a slow fire, and once in an hour take off the paper, and you will find some flour sticking to it, which return again in the pot; this you must continue till the flour appears white and fine. There is also an oil of benjamin, which is sometimes drawn from the dregs of the flour; it affords a very good scent, and may be used in wet compositions.

7. *Spur-fire.*

This fire is the most beautiful and curious of any yet known; and was invented by the Chinese, but now is in greater perfection in England than in China. As it requires great trouble to make it to perfection, it will be necessary that beginners should have full instructions; therefore care should be taken that all the ingredients are of the best, that the lamp-black is not damp and clodded, that the saltpetre and brimstone are thoroughly refined. This composition is generally rammed in 1 or 2 oz. cases about 5 or 6 inches long, but not drove very hard; and the cases must have their concave stroke struck very smooth, and the choak or vent not quite so large as the usual proportion: this charge, when driven and kept a few months, will be much better than when rammed; and will not spoil, if kept dry, in many years.

As the beauty of this composition cannot be seen at so great a distance as brilliant fire, it has a better effect in a room than in the open air, and may be fired in a chamber without any danger: it is of so innocent a nature, that, though with an improper phrase, it may be called a *cold fire*; and so extraordinary is the fire produced from this composition, that, if well made, the sparks will not burn a handkerchief when held in the midst of them; you may hold them in your hand while burning, with as much safety as a candle; and if you put your hand within a foot of the mouth of the case, you will feel the sparks like drops of rain.—When any of these spur-fires are fired singly, they are called *artificial flower-pots*; but some of them placed round a transparent pyramid of paper, and fired in a large room, make a very pretty appearance.

The composition consists of saltpetre 4 lb. 8 oz. sulphur 2 lb. and lamp-black 1 lb. 8 oz.; or, saltpetre 1 lb. sulphur $\frac{1}{2}$ lb. and lamp-black 4 quarts.—This composition is very difficult to mix. The saltpetre and brimstone must be first sifted together, and then put into a marble mortar, and the lamp-black with them, which you work down by degrees with a wooden pestle, till all the ingredients appear of one colour, which will be something greyish, but very near black: then drive a little into a case for trial, and fire it in a dark place; and if the sparks, which are called *stars*, or *pinks*, come out in clusters, and afterwards spread well without any other sparks, it is a sign of its being good, otherwise not; for if any drossy sparks appear, and the stars not full, it is then not mixed enough; but if the pinks are very small, and soon break, it is a sign that you have rubbed it too much.

This mixture, when rubbed too much, will be too fierce, and hardly show any stars; and, on the contrary, when not mixed enough, will be too weak, and throw out an obscure smoke, and lumps of dross, without any stars. The reason of this charge being called the *spur-fire*, is because the sparks it yields have a great resemblance to the rowel of a spur, from whence it takes its name.

8. *To meal Gunpowder, Brimstone, and Charcoal.*

There have been many methods used to grind these ingredients to a powder for fire-works, such as large mortars and pestles made of ebony and other hard wood, and horizontal mills with brass barrels: but none have proved so effectual and speedy as the last invention, that of the mealing-table, represented in fig. 1. made of elm, with a rim round its edge 4 or 5 inches high; and at the narrow end A, is a slider that runs in a groove, and forms part of the rim: so that when you have taken out of the table as much powder as you can with the copper shovel (fig. 2.) sweep all clean out at the slider A. When you are going to meal a quantity of powder, observe not to put too much in the table at once; but when you have put in a good proportion, take the muller (fig. 3.) and rub it till all the grains are broke: then searce it in a lawn sieve that has a receiver and top to it; and that which does not pass through the sieve, return again to the table, and grind it till you have brought it all fine enough to go through the sieve. Brimstone and charcoal are ground in the same manner, only the muller must be made of ebony; for these ingredients being harder than powder, would stick in the grain of elm, and be difficult to grind. As brimstone is apt to stick and clod to the table, it will be best to keep one for that purpose, by which means you will always have your brimstone clean and well ground.

Plate CCCCX.

2d 8. *To make Wheels and other Works incombustible.*

It being necessary, when your works are new, to paint them of some dark colour; therefore, if, instead of which, you make use of the following composition, it will give them a good colour, and in a great measure prevent their taking fire so soon as if painted. Take brick-dust, coal-ashes, and iron-filings, of each an equal quantity, and mix them with a double size, made hot. With this wash over your works, and when dry wash them over again; this will preserve the wood greatly against fire. Let the brick-dust and ashes be beat to a fine powder.

9. *To prepare Cast-iron for Gerbes, white Fountains, and Chinese Fire.*

Cast iron being of so hard a nature as not to be cut by a file, we are obliged to reduce it into grains, though somewhat difficult to perform; but if we consider what beautiful sparks this sort of iron yields, no pains should be spared to granulate such an essential material: to do which, get at an iron-foundery some thin pieces of iron, such as generally run over the mould at the time of casting: then have a square block made of cast iron, and an iron square hammer about four lb. weight; then, having covered the floor with cloth or something to catch the beatings, lay the thin pieces of iron on the block, and beat them with the hammer till reduced into small grains; which afterwards searce with a very fine sieve, to separate the fine dust, which is sometimes used in small cases of brilliant fire, instead of steel dust; and when you have got out all the dust, sift what remains with a sieve a little larger, and so on with sieves of different sizes, till

dients and Compositions. till the iron paffes through about the bignefs of fmall bird-fhot: your iron thus beat and fifted, put each fort into wooden boxes or oiled paper, to keep it from rufting. When you ufe it, obferve the difference of its fize, in proportion to the cafes for which the charge is intended; for the coarfe fort is only defigned for very large gerbes of 6 or 8 lb.

10. *Charges for Sky-rockets*, &c.

Rockets of four ounces. Mealed powder 1 lb. 4 oz. faltpetre 4 oz. and charcoal 2 oz.

Rockets of eight ounces. I. Mealed powder 1 lb. faltpetre 4 oz. brimftone 3 oz. and charcoal 1½ oz. II. Meal-powder 1½ lb. and charcoal 4¾ oz.

Rockets of one pound. Meal-powder 2 lb. faltpetre 8 oz. brimftone 4 oz. charcoal 2 oz. and fteel-filings 1½ oz.

Sky-rockets in general. I. Saltpetre 4 lb. brimftone 1 lb. and charcoal 1½ lb. II. Saltpetre 4 lb. brimftone 1½ lb. charcoal 1 lb. 12 oz. and meal-powder 2 oz.

Large fky-rockets. Saltpetre 4 lb. meal-powder 1 lb. and brimftone 1 lb.

Rockets of a middling fize. I. Saltpetre 8 lb. fulphur 3 lb. meal-powder 3 lb. II. Saltpetre 3 lb. fulphur 2 lb. meal-powder 1 lb. charcoal 1 lb.

11. *For Rocket Stars.*

White Stars. Meal-powder 4 oz. faltpetre 12 oz. fulphur vivum 6 oz. oil of fpike 2 oz. and camphor 5 oz.

Blue ftars. Meal-powder 8 oz. faltpetre 4, fulphur 2, fpirit of wine 2, and oil of fpike 2.

Coloured or variegated ftars. Meal-powder 8 drams, rochpetre 4 oz. fulphur vivum 2, and camphor 2.

Brilliant ftars. Saltpetre 3½ oz. fulphur 1½, and meal-powder ½, worked up with fpirits of wine only.

Common ftars. Saltpetre 1 lb. brimftone 4 oz. antimony 4½, ifinglafs ½, camphor ½, and fpirit of wine ½.

Tailed ftars. Meal-powder 3 oz. brimftone 2, faltpetre 1, and charcoal (coarfely ground) ½.

Drove ftars. I. Saltpetre 3 lb. fulphur 1 lb. brafs duft 12 oz. antimony 3. II. Saltpetre 1 lb. antimony 4 oz. and fulphur 8.

Fixed pointed ftars. Saltpetre 8½ oz. fulphur 2, antimony 1 oz. 10 dr.

Stars of a fine colour. Sulphur 1 oz. meal-powder 1, faltpetre 1, camphor 4 dr. oil of turpentine 4 dr.

12. *Rains.*

Gold rain for fky-rockets. I. Saltpetre 1 lb. meal-powder 4 oz. fulphur 4, brafs-duft 1, faw-duft 2¼, and glafs-duft 6 dr. II. Meal-powder 12 oz. faltpetre 2, charcoal 4. III. Saltpetre 8 oz. brimftone 2, glafs-duft 1, antimony ¾, brafs-duft ¼, and faw-duft 12 dr.

Silver rain. I. Saltpetre 4 oz. fulphur, meal-powder, and antimony, of each 2 oz. fal prunella ½ oz. II. Saltpetre ½ lb. brimftone 2 oz. and charcoal 4. III. Saltpetre 1 lb. brimftone ½ lb. antimony 6 oz. IV. Saltpetre 4 oz. brimftone 1, powder 2, and fteel-duft ¼ oz.

13. *Water Rockets.*

I. Meal-powder 6 lb. faltpetre 4, brimftone 3, charcoal 5. II. Saltpetre 1 lb. brimftone 4½ oz. charcoal 6. III. Saltpetre 1 lb. brimftone 4 oz. charcoal 12. IV. Saltpetre 4 lb. brimftone 1½ lb. charcoal 1 lb. 12 oz. V. Brimftone 2 lb. faltpetre 4 lb. and meal-powder 4. VI. Saltpetre 1 lb. meal-powder 4 oz. brimftone 8½, charcoal 2. VII. Meal-powder 1 lb. faltpetre 3, brimftone 1; fea-coal 1 oz. charcoal 8½, faw-duft ¾, fteel-duft ½, and coarfe charcoal ¼ oz. VIII. Meal-powder 1¼ lb. faltpetre 3, fulphur 1½, charcoal 12 oz. faw-duft 2.

Sinking charge for water-rockets. Meal-powder 8 oz. charcoal ¼ oz.

14. *Of Wheels.*

Wheel-cafes from two ounces to four pounds. I. Meal-powder 2 lb. faltpetre 4 oz. iron-filings 7. II. Meal-powder 2 lb. faltpetre 12 oz. fulphur 4, fteel-duft 3. III. Meal-powder 4 lb. faltpetre 1 lb. brimftone 8 oz. charcoal 4½. IV. Meal-powder 8 oz. faltpetre 4, faw-duft 1½, fea-coal ¾. V. Meal-powder 1 lb. 4 oz. brimftone 4 oz. 10 dr. faltpetre 8 oz. glafs-duft 2½. VI. Meal-powder 12 oz. charcoal 1, faw-duft ½. VII. Saltpetre 1 lb. 9 oz. brimftone 4 oz. charcoal 4½. VIII. Meal-powder 2 lb. faltpetre 1, brimftone ½, and fea-coal 2 oz. IX. Saltpetre 2 lb. brimftone 1, meal-powder 4, and glafs-duft 4 oz. X. Meal-powder 1 lb. faltpetre 2 oz. and fteel-duft 3½. XI. Meal-powder 2 lb. and fteel-duft 2¼ oz. with 2½ of the fine duft of beat iron. XII. Saltpetre 2 lb. 13 oz. brimftone 8 oz. and charcoal.

Slow fire for wheels. I. Saltpetre 4 oz. brimftone 2, and meal-powder 1¼. II. Saltpetre 4 oz. brimftone 1, and antimony 1 oz. 6 dr. III. Saltpetre 4½oz. brimftone 1 oz. and mealed powder 1½.

Dead fire for wheels. I. Saltpetre 1¼ oz. brimftone ½, lapis-calaminaris ½, and antimony 2 dr.

15. *Standing or fixed Cafes.*

I. Meal-powder 4 lb. faltpetre 2, brimftone and charcoal 1. II. Meal-powder 2 lb. faltpetre 1, and fteel-duft 8 oz. III. Meal-powder 1 lb. 4 oz. and charcoal 4 oz. IV. Meal-powder 1 lb. and fteel-duft 4 oz. V. Meal-powder 2½ lb. brimftone 4 oz. and fea-coal 6. VI. Meal-powder 3 lb. charcoal 5 oz. and faw-duft 1½.

16. *Sun Cafes.*

I. Meal-powder 8½ lb. faltpetre 1 lb. 2 oz. fteel-duft 2 lb. 10 oz. brimftone 4. II. Meal-powder 3 lb. faltpetre 6 oz. and fteel-duft 7½.

17. *A brilliant Fire.*

Meal-powder 11 lb. faltpetre 1, brimftone 4 oz. fteel-duft 1½ lb.

18. *Gerbes.*

Meal-powder 6 lb. and beat-iron 2 lb. 1½. oz.

19. *Chinefe Fire.*

Saltpetre 12 oz. meal-powder 2 lb. brimftone 1 lb. 2 oz. and beat iron 12 oz.

20. *Tourbillons.*

Charge for four-ounce Tourbillons. Meal-powder 2 lb. 4 oz. and charcoal 4½ oz.

Eight-ounce Tourbillons. Meal-powder 2 lb. and charcoal 4¾ oz.

Large Tourbillons. Meal-powder 2 lb. faltpetre 1, brimftone 8 oz. and beat iron 8.

N. B. Tourbillons may be made very large, and of different coloured fires: only you are to obferve, that the larger they are, the weaker muft be the charge; and, on the contrary, the fmaller, the ftronger their charge.

Ingredients and Compositions.

21. Water Balloons.

I. Saltpetre 4 lb. brimstone 2, meal-powder 2, antimony 4 oz. saw-dust 4, and glass-dust $1\frac{1}{4}$. II. Saltpetre 9 lb. brimstone 3 lb. meal-powder 6 lb. rosin 12 oz. and antimony 8 oz.

22. Water Squibs.

I. Meal-powder 1 lb. and charcoal 1 lb. II. Meal-powder 1 lb. and charcoal 9 oz.

23. Mine Ports or Serpents.

I. Meal-powder 1 lb. and charcoal 1 oz. II. Meal-powder 9 oz. charcoal 1 oz.

24. Port-fires.

For firing rockets, &c. I. Saltpetre 12 oz. brimstone 4 oz. and meal-powder 2 oz. II. Saltpetre 8 oz. brimstone 4 oz. and meal-powder 2 oz. III. Saltpetre 1 lb 2 oz. meal-powder $1\frac{1}{2}$ lb. and brimstone 10 oz. This composition must be moistened with one gill of linseed oil. IV. Meal-powder 6 oz. saltpetre 2 lb. 2 oz. and brimstone 10 oz. V. Saltpetre 1 lb. 4 oz. meal-powder 4 oz. brimstone 5 oz. saw-dust 8 oz. VI. Saltpetre 8 oz. brimstone 2 oz. and meal-powder 2 oz.

For illuminations. Saltpetre 1 lb. brimstone 8 oz. and meal-powder 6 oz.

25. Cones or spiral Wheels.

Saltpetre $1\frac{1}{2}$ lb. brimstone 6 oz. meal-powder 14 oz. and glass-dust 14 oz.

26. Crowns or Globes.

Saltpetre 6 oz. brimstone 2 lb. antimony 4 oz. and camphor 2 oz.

27. Air Balloon Fuzes.

I. Saltpetre 1 lb. 10 oz. brimstone 8 oz. and meal-powder 1 lb. 6 oz. II. Saltpetre $1\frac{1}{4}$ lb. brimstone 8 oz. and meal-powder 1 lb. 8 oz.

28. Serpents for Pots des Brins.

Meal-powder 1 lb. 8 oz. saltpetre 12 oz. and charcoal 2 oz.

29. Fire Pumps.

I. Saltpetre 5 lb. brimstone 1 lb. meal-powder $1\frac{1}{2}$ lb. and glass-dust 1 lb. II. Saltpetre 5 lb. 8 oz. brimstone 2 lb. meal-powder 1 lb. 8 oz. and glass-dust 1 lb. 8 oz.

30. A slow white Flame.

I. Saltpetre 2 lb. brimstone 3 lb. antimony 1 lb. II. Saltpetre $3\frac{1}{2}$ lb. sulphur $2\frac{1}{4}$ lb. meal-powder 1 lb. antimony $\frac{1}{4}$ lb. glass-dust 4 oz. brass-dust 1 oz.

N. B. These compositions, driven $1\frac{1}{4}$ inch in a 1 oz. case, will burn one minute, which is much longer time than an equal quantity of any composition yet known will last.

31. Amber Lights.

Meal-powder 9 oz. amber 3 oz. This charge may be drove in small cases, for illuminations.

32. Lights of another Kind.

Saltpetre 3 lb. brimstone 1 lb. meal-powder 1 lb. antimony $10\frac{1}{2}$ oz. All these must be mixed with the oil of spike.

33. A red Fire.

Meal-powder 3 lb. charcoal 12 oz. and saw-dust 8 oz.

34. A common Fire.

Saltpetre 3 lb. charcoal 10 oz. and brimstone 2 oz.

35. To make an artificial Earthquake.

Mix the following ingredients to a paste with water, and then bury it in the ground, and in a few hours the earth will break and open in several places. The composition: sulphur 4 lb. and steel-dust 4 lb.

36. Compositions for Stars of different Colours.

I. Meal-powder 4 oz. saltpetre 2 oz. brimstone 2 oz. steel-dust $1\frac{1}{2}$ oz. and camphor, white amber, antimony, and mercury-sublimate, of each $\frac{1}{2}$ oz. II. Rochepetre 10 oz. brimstone, charcoal, antimony, meal-powder, and camphor, of each $\frac{1}{4}$ oz. moistened with oil of turpentine. These compositions are made into stars, by being worked to a paste with aqua vitæ, in which has been dissolved some gum-tragacanth; and after you have rolled them in powder, make a hole through the middle of each, and string them on quick-match, leaving about 2 inches between each. III. Saltpetre 8 oz. brimstone 2 oz. yellow amber 1 oz. antimony 1 oz. and powder 3 oz. IV. Brimstone $2\frac{1}{2}$ oz. saltpetre 6 oz. olibanum or frankincense in drops 4 oz.; mastick, and mercury-sublimate, of each 4 oz. meal-powder 5 oz. white amber, yellow amber, and camphor, of each 1 oz. antimony and orpiment $\frac{1}{2}$ oz. each. V. Saltpetre 1 lb. brimstone $\frac{1}{2}$ lb. and meal-powder 8 oz. moistened with petrolio-oil. VI. Powder $\frac{1}{2}$ lb. brimstone and saltpetre, of each 4 oz. VII. Saltpetre 4 oz. brimstone 2 oz. and meal-powder 1 oz.

Stars that carry tails of sparks. I. Brimstone 6 oz. antimony crude 2 oz. saltpetre 4 oz. and rosin 4 oz. II. Saltpetre, rosin, and charcoal, of each 2 oz. brimstone 1 oz. and pitch 1 oz.

These compositions are sometimes melted in an earthen pan, and mixed with chopped cotton-match, before they are rolled into stars; but will do as well if wetted, and worked up in the usual manner.

Stars that yield some sparks. I. Camphor 2 oz. saltpetre 1 oz. meal-powder 1 oz. II. Saltpetre 1 oz. ditto melted $\frac{1}{2}$ oz. and camphor 2 oz. When you would make stars of either of these compositions, you must wet them with gum-water, or spirit of wine, in which has been dissolved some gum-arabic, or gum-tragacanth, that the whole may have the consistence of a pretty thick liquid; having thus done, take 1 oz. of lint, and stir it about in the composition till it becomes dry enough to roll into stars.

Stars of a yellowish colour. Take 4 oz. of gum-tragacanth or gum-arabic, pounded and sifted through a fine sieve, camphor dissolved in brandy 2 oz. saltpetre 1 lb. sulphur $\frac{1}{2}$ lb. coarse powder of glass 4 oz. white amber $1\frac{1}{2}$ oz. orpiment 2 oz. Being well incorporated, make them into stars after the common method.

Stars of another kind. Take 1 lb. of camphor, and melt it in a pint of spirit of wine over a slow fire; then add to it 1 lb. of gum-arabic that has been dissolved; with this liquor mix 1 lb. of saltpetre, 6 oz. of sulphur, and 5 oz. of meal-powder; and after you have stirred them well together, roll them into stars proportionable to the rockets for which you intend them.

37. Colours produced by the different Compositions.

As variety of fires adds greatly to a collection of works, it is necessary that every artist should know the different effect of each ingredient. For which reason, we shall here explain the colours they produce of themselves; and likewise how to make them retain the same when mixed with other bodies: as for example, sulphur

ments and Posi-tions. sulphur gives a blue, camphor a white or pale colour, saltpetre a clear white-yellow, amber a colour inclining to yellow, sal-ammoniac a green, antimony a reddish, rosin a copper colour, and Greek-pitch a kind of bronze, or between red and yellow. All these ingredients are such as show themselves in a flame, viz.

White flame. Saltpetre, sulphur, meal-powder, and camphor; the saltpetre must be the chief part.

Blue flame. Meal-powder, saltpetre, and sulphur vivum; sulphur must be the chief: Or meal-powder, saltpetre, brimstone, spirit of wine, and oil of spike; but let the powder be the principal part.

Flame inclining to red. Saltpetre, sulphur, antimony, and Greek-pitch; saltpetre the chief.

By the above method may be made various colours of fire, as the practitioner pleases; for, by making a few trials, he may cause any ingredient to be predominant in colour.

38. *Ingredients that show in Sparks when rammed in choak'd Cases.*

The set colours of fire produced by sparks are divided into 4 sorts, viz. the black, white, grey, and red. The black charges are composed of 2 ingredients, which are meal-powder and charcoal; the white of 3, viz. saltpetre, sulphur, and charcoal; the grey of 4, viz. meal-powder, saltpetre, brimstone, and charcoal; and the red of 3, viz. meal-powder, charcoal, and saw-dust.

There are, besides these four regular or set charges, two others, which are distinguished by the names of *compound* and *brilliant charges;* the compound being made of many ingredients, such as meal-powder, saltpetre, brimstone, charcoal, saw-dust, sea-coal, antimony, glass dust, brass dust, steel filings, cast iron, tanner's dust, &c. or any thing that will yield sparks; all which must be managed with discretion. The brilliant fires are composed of meal-powder, saltpetre, brimstone, and steel dust; or with meal-powder and steel filings only.

39. *Cotton Quick-match,*

Is generally made of such cotton as is put in candles, of several sizes, from 1 to 6 threads thick, according to the pipe it is designed for; which pipe must be large enough for the match, when made, to be pushed in easily without breaking it. Having doubled the cotton into as many threads as you think proper, coil it very lightly into a flat-bottomed copper or earthen pan; then put in the saltpetre and the liquor, and boil them about 20 minutes; after which coil it again into another pan, as in fig. 4. and pour on it what liquor remains; then put in some meal-powder, and press it down with your hands till it is quite wet; afterwards place the pan before the wooden frame (fig. 5.) which must be suspended by a point in the centre of each end; and place yourself before the pan, tying the upper end of the cotton to the end of one of the sides of the frame.

Plate CCCXVIII.

When every thing is ready, you must have one to turn the frame round, while you let the cotton pass through your hands, holding it very lightly, and at the same time keeping your hands full of the wet powder; but if the powder should be too wet to stick to the cotton, put more in the pan, so as to keep a continual supply till the match is all wound up; you may wind it as close on the frame as you please, so that it do not stick together; when the frame is full, take it off the points, and sift dry meal-powder on both sides the match, till it appear quite dry: in winter the match will be a fortnight before it is fit for use; when it is thoroughly dry, cut it along the outside of one of the sides of the frame, and tie it up in skins for use.

Of Moulds, Cases, Mixture, Instruments, &c.

N. B. The match must be wound tight on the frames.

The ingredients for the match, are, cotton 1 lb. 12 oz. saltpetre 1 lb. spirit of wine 2 quarts, water 3 quarts, isinglass 3 gills, and meal-powder 10 lb. To dissolve 4 oz. of isinglass, take 3 pints of water.

2d 39. *Touch-paper for capping of Serpents, Crackers,* &c.

Dissolve, in spirits of wine or vinegar, a little saltpetre; then take some purple or blue paper, and wet it with this liquor, and when dry it will be fit for use; when you paste this paper on any of your works, take care that the paste does not touch that part which is to burn. The method of using this paper is by cutting it into slips, long enough to go once round the mouth of a serpent, cracker, &c. When you paste on these slips, leave a little above the mouth of the case not pasted; then prime the case with meal-powder, and twist the paper to a point.

SECT. II. *Of Moulds, Cases, Mixture, Instruments, &c.*

40. *Rocket moulds.*

As the performance of rockets depends much on their moulds, it is requisite to give a definition of them and their proportions: They are made and proportioned by the diameter of their orifice, which are divided into = parts. Fig. 6. represents a mould made by its diameter AB: its height from C to D is 6 diameters and 2 thirds; from D to E is the height of the foot, which is 1 diameter and 2 thirds; F the choak or cylinder, whose height is 1 diameter and 1-3d; it must be made out of the same piece as the foot, and fit tight in the mould; G an iron pin that goes through the cylinder to keep the foot fast; H the nipple, which is $\frac{1}{2}$ a diameter high, and 2-3ds thick, and of the same piece of metal as the former I, whose height is $3\frac{1}{2}$ diameters, and at the bottom is 1-3d of the diameter thick, and from thence tapering to 1-6th of the diameter. The best way to fix the piercer in the cylinder, is to make that part below the nipple long enough to go quite through the foot, and rivet at bottom. Fig. 7. is a former or roller for the cases, whose length from the handle is $7\frac{1}{2}$ diameters, and its diameter 2-3ds of the bore. Fig. 8. the end of the former, which is of the same thickness, and 1 diameter and 2-3ds long; the small part, which fits into the hole in the end of the roller when the case is pinching, is 1-6th and $\frac{1}{4}$ of the mould's diameter thick. Fig. 9. the first drift, which must be 6 diameters from the handle; and this, as well as all other rammers, must be a little thinner than the former, to prevent the sacking of the paper when you are driving in the charge. In the end of this rammer is a hole to fit over the piercer: the line K marked on this is 2 diameters and 1-3d from the handle; so that, when you are filling the rocket, this line appears at top of the case: you must then take the 2d rammer (fig. 10.) which from the handle is 4 diameters,

Of Moulds, Cases, Mixture, Instruments, &c.

diameters, and the hole for the piercer is 1½ diameter long. Fig. 11. is the short and solid drift which you use when you have filled the case as high as the top of the piercer.

Rammers must have a collar of brass at the bottom, to keep the wood from spreading or splitting, and the same proportion must be given to all moulds, from 1 oz. to 6 lb. We mentioned nothing concerning the handles of the rammers; however, if their diameter be equal to the bore of the mould, and 2 diameters long, it will be a very good proportion: but the shorter you can use them, the better; for the longer the drift, the less will be the pressure on the composition by the blow given with the mallet.

Dimensions for Rocket Moulds, if the Rockets are rammed solid.

Weight of rockets.	Length of the moulds without their feet.	Interior diameter of the moulds.	Height of the nipples.
lb. oz.	Inches.	Inches.	Inches.
6 0	34,7	3,5	1,5
4 0	38,6	2,9	1,4
2 0	13,35	2,1	1,0
1 0	12,25	1,7	0,85
0 8	10,125	1,333, &c.	0,6
0 4	7,75	1,125	0,5
0 2	6,2	0,9	0,45
0 1	4,9	0,7	0,35
0 ½	3,9	0,55	0,25
6 drams	3,5	0,5	0,225
4 drams	2,2	0,3	0,2

The diameter of the nipple must always be equal to that of the former.

The thickness of the moulds is omitted, being very immaterial, provided they are substantial and strong.

Our author advises those who make rockets for private amusement, not to ram them solid; for it requires a very skilful hand, and an expensive apparatus for boring them, which will be shown hereafter. Driving of rockets solid is the most expeditious method, but not so certain as ramming them over a piercer.

41. *Moulds for Wheel-cases or Serpents.*

Fig. 12. represents a mould, in which the cases are drove solid; L the nipple (A), with a point (B) at top, which, when the case is filling, serves to stop the neck, and prevent the composition from falling out, which without this point it would do; and, in consequence, the air would get into the vacancy in the charge, and at the time of firing cause the case to burst. These sort of moulds are made of any length or diameter, according as the cases are required; but the diameter of the rollers must be equal to half the bore, and the rammers made quite solid.

42. *To roll Rocket and other Cases.*

Sky-rocket cases are to be made 6½ of their exterior diameter long; and all other cases that are to be filled in moulds must be as long as the moulds, within half its interior diameter.

Rocket cases, from the smallest to 4 or 6 lb. are generally made of the strongest sort of cartridge paper, and rolled dry; but the large sort are made of pasted pasteboard. As it is very difficult to roll the ends of the cases quite even, the best way will be to keep a pattern of the paper for the different sorts of cases; which pattern should be somewhat longer than the case it is designed for, and on it marked the number of sheets required, which will prevent any paper being cut to waste. Having cut your papers of a proper size, and the last sheet for each case with a slope at one end, so that when the cases are rolled it may form a spiral line round the outside, and that this slope may always be the same, let the pattern be so cut for a guide. Before you begin to roll, fold down one end of the first sheet, so far that the fold will go 2 or 3 times round the former: then, on the double edge, lay the former with its handle off the table; and when you have rolled on the paper within 2 or 3 turns, lay the next sheet on that part which is loose, and roll it all on.

Having thus done, you must have a smooth board, about 20 inches long, and equal in breadth to the length of the case. In the middle of this board must be a handle placed lengthwise. Under this board lay your case, and let one end of the board lie on the table; then press hard on it, and push it forwards, which will roll the paper very tight: do this three or four times before you roll on any more paper. This must be repeated every other sheet of paper, till the case is thick enough; but if the rolling board be drawn backwards, it will loosen the paper: you are to observe, when you roll on the last sheet, that the point of the slope be placed at the small end of the roller. Having rolled your case to fit the mould, push in the small end of the former F, about 1 diameter from the end of the case, and put in the end-piece within a little distance of the former; then give the pinching cord one turn round the case, between the former and the end-piece; at first pull easy, and keep moving the case, which will make the neck smooth, and without large wrinkles. When the cases are hard to choak, let each sheet of paper (except the first and last, in that part where the neck is formed) be a little moistened with water: immediately after you have struck the concave stroke, bind the neck of the case round with small twine, which must not be tied in a knot, but fastened with two or three hitches.

Having thus pinched and tied the case so as not to give way, put it into the mould without its foot, and with a mallet drive the former hard on the end-piece, which will force the neck close and smooth. This done, cut the case to its proper length, allowing from the neck to the edge of the mouth half a diameter, which is equal to the height of the nipple; then take out the former, and drive the case over the piercer with the long rammer, and the vent will be of a proper size. Wheel-cases must be drove on a nipple with a point to close

(A) The nipple and cylinders to bear the same proportion as those for rockets.
(B) A round bit of brass, equal in length to the neck of the case, and flat at the top.

close the neck, and make the vent of the size required; which, in most cases, is generally ¼ of their interior diameter. As it is very often difficult, when the cases are rolled, to draw the roller out, you may make a hole through the handle, and put in it a small iron pin, by which you may easily turn the former round and pull it out. Fig. 17. shows the method of pinching cases; P a treddle, which, when pressed hard with the foot, will draw the cord tight, and force the neck as close as you please; Q a small wheel or pulley, with a groove round it for the cord to run in.

Cases are commonly rolled wet, for wheels and fixed pieces; and when they are required to contain a great length of charge, the method of making those cases is thus: Your paper must be cut as usual, only the last sheet must not be cut with a slope: having your paper ready, paste each sheet on one side; then fold down the first sheet as before directed: but be careful that the paste do not touch the upper part of the fold; for if the roller be wetted, it will tear the paper in drawing it out. In pasting the last sheet, observe not to wet the last turn or two in that part where it is to be pinched; for if that part be damp, the pinching cord will stick to it, and tear the paper; therefore, when you choak those cases, roll a bit of dry paper once round the case, before you put on the pinching cord; but this bit of paper must be taken off after the case is choaked. The rolling board, and all other methods, according to the former directions for the rolling and pinching of cases, must be used to these as well as all other cases.

43. *To make Tourbillon Cases.*

Those sort of cases are generally made about 8 diameters long; but if very large, 7 will be sufficient: tourbillons will answer very well from 4 oz. to 2 lb. but when larger there is no certainty. The cases are best rolled wet with paste, and the last sheet must have a straight edge, so that the case may be all of a thickness: when you have rolled your cases after the manner of wheel-cases, pinch them at one end quite close; then with the rammer drive the ends down flat, and afterwards ram in about 1-3d of a diameter of dried clay. The diameter of the former for these cases must be the same as for sky-rockets.

N. B. Tourbillons are to be rammed in moulds without a nipple, or in a mould without its foot.

44. *Balloon Cases, or Paper Shells.*

First, you must have an oval former turned of smooth wood; then paste a quantity of brown or cartridge paper, and let it lie till the paste has quite soaked through; this done, rub the former with soap or grease, to prevent the paper from sticking to it; then lay the paper on in small slips, till you have made it 1-3d of the thickness of the shell intended. Having thus done, set it to dry; and when dry, cut it round the middle, and the two halves will easily come off: but observe, when you cut, to leave about 1 inch not cut, which will make the halves join much better than if quite separated. When you have some ready to join, place the halves even together, paste a slip of paper round the opening to hold them together, and let that dry; then lay on paper all over as before, everywhere equal, excepting that end which goes downwards in the mortar, which may be a little thicker than the rest; for that part which receives the blow from the powder in the chamber of the mortar consequently requires the greatest strength. When the shell is thoroughly dry, burn a round vent at top, with square iron, large enough for the fuze; this method will do for balloons from 4 inches 2-5ths, to 8 inches diameter; but if they are larger, or required to be thrown a great height, let the first shell be turned of elm, instead of being made of paper.

For a balloon of 4 inches 2-5ths, let the former be 3 inches 1-8th diameter, and 5½ inches long. For a balloon of 5½ inches, the diameter of the former must be 4 inches, and 8 inches long. For a balloon of 8 inches, let the diameter of the former be 5 inches and 15-16ths, and 11 inches 7-8ths long. For a 10-inch balloon, let the former be 7 inches 3-16ths diameter, and 14½ inches long. The thickness of a shell for a balloon of 4 inches 2-5ths, must be ½ inch. For a balloon of 5½ inches, let the thickness of the paper be 5-8ths of an inch. For an 8-inch balloon, 7-8ths of an inch. And for a 10-inch balloon, let the shell be 1 inch 1-8th thick.

Shells that are designed for stars only, may be made quite round, and the thinner they are at the opening, the better; for if they are too strong, the stars are apt to break at the bursting of the shell: when you are making the shell, make use of a pair of calibres, or a round gage, so that you may not lay the paper thicker in one place than another; and also to know when the shell is of a proper thickness. Balloons must always be made to go easy into the mortars.

Cases for illumination Port-fires. These must be made very thin of paper, and rolled on formers, from 2 to 5-8ths of an inch diameter, and from 2 to 6 inches long: they are pinched close at one end, and left open at the other. When you fill them, put in but a little composition at a time, and ram it in lightly, so as not to break the case: 3 or 4 rounds of paper, with the last round pasted, will be strong enough for these cases.

Cases and moulds for common Port-fires. Common port-fires are intended purposely to fire the works, their fire being very slow, and the heat of the flame so intense, that, if applied to rockets, leaders, &c. it will fire them immediately. Port-fires may be made of any length, but are seldom made more than 21 inches long: the interior diameter of port-fire moulds should be 10-16ths of an inch, and the diameter of the former ½ an inch. The cases must be rolled wet with paste, and one end pinched, or folded down. The moulds should be made of brass, and to take in two pieces lengthwise; when the case is in the two sides, they are held together by brass rings, or hoops, which are made to fit over the outside. The bore of the mould must not be made quite through, so that there will be no occasion for a foot. Those port-fires, when used, are held in copper sockets, fixed on the end of a long stick: these sockets are made like port-crayons, only with a screw instead of a ring.

45. *Of mixing the Compositions.*

The performance of the principal part of fire-works depends much on the compositions being well mixed; therefore great care must be taken in this part of the work, particularly for the composition for sky-rockets. When you have 4 or 5 pounds of ingredients to mix, which is a sufficient quantity at a time (for a larger proportion

Of Moulds, Cases, Mixture, Instruments, &c.

proportion will not do so well), first put the different ingredients together; then work them about with your hands, till you think they are pretty well incorporated: after which put them into a lawn sieve with a receiver and top to it; and if, after it is sifted, any remains that will not pass through the sieve, grind it again till fine enough; and if it be twice sifted, it will not be amiss; but the compositions for wheels and common works are not so material, nor need be so fine. But in all fixed works, from which the fire is to play regular, the ingredient must be very fine, and great care taken in mixing them well together; and observe, that in all compositions wherein are steel or iron filings, the hands must not touch; nor will any works which have iron or steel in their charge keep long in damp weather, unless properly prepared, according to the following directions.

46. *To preserve Steel or Iron filings.*

It sometimes may happen, that fire-works may be required to be kept a long time, or sent abroad; neither of which could be done with brilliant fires, if made with filings unprepared; for this reason, that the saltpetre being of a damp nature, it causes the iron to rust; the consequence of which is, that when the works are fired, there will appear but very few brilliant sparks, but instead of them a number of red and drossy sparks; and besides, the charge will be so much weakened, that if this was to happen to wheels, the fire will hardly be strong enough to force them round. But to prevent such accidents, prepare your filings thus: Melt in a glazed earthen pan some brimstone over a slow fire, and when melted throw in some filings; which keep stirring about till they are covered with brimstone: this you must do while it is on the fire; then take it off, and stir it very quick till cold, when you must roll it on a board with a wooden roller, till you have broke it as fine as corn powder; after which sift from it as much of the brimstone as you can. There is another method of preparing filings, so as to keep 2 or 3 months in winter; this may be done by rubbing them between the strongest sort of brown paper, which before has been moistened with lintseed oil.

N. B. If the brimstone should take fire, you may put it out, by covering the pan close at top: it is not of much signification what quantity of brimstone you use, so that there is enough to give each grain of iron a coat; but as much as will cover the bottom of a pan of about 1 foot diameter, will do for 5 or 6 pound of filings, or cast-iron for gerbes.

47. *To drive or ram Sky-rockets*, &c.

Rockets drove over a piercer must not have so much composition put in them at a time as when drove solid; for the piercer, taking up great part of the bore of the case, would cause the rammer to rise too high; so that the pressure of it would not be so great on the composition, nor would it be drove everywhere equal. To prevent this, observe the following rule: That for those rockets which are rammed over a piercer, let the ladle (C) hold as much composition as, when drove, will raise the drift $\frac{1}{2}$ the interior diameter of the case, and for those drove solid to contain as much as will raise it $\frac{1}{2}$ the exterior diameter of the case: ladles are generally made to go easy in the case, and the length of the scoop about $1\frac{1}{2}$ of its own diameter.

The change of rockets must always be drove 1 diameter above the piercer, and on it must be rammed 1-3d of a diameter of clay; through the middle of which bore a small hole to the composition, that, when the charge is burnt to the top, it may communicate its fire, through the hole, to the stars in the head. Great care must be taken to strike with the mallet, and with an equal force, the same number of strokes to each ladle-full of charge; otherwise the rockets will not rise with an uniform motion, nor will the composition burn equal and regular: for which reason they cannot carry a proper tail; for it will break before the rocket has got half way up, instead of reaching from the ground to the top, where the rocket breaks and disperses the stars, rains, or whatever is contained in the head. When you are ramming, keep the drift constantly turning or moving; and when you use the hollow rammers, knock out of them the composition now and then, or the piercer will split them. To a rocket of 4 oz. give to each ladle-full of charge 16 strokes; to a rocket of 1 lb. 28; to a 2-pounder, 36; to a 4-pounder, 42; and to a 6-pounder, 56: but rockets of a larger sort cannot be drove well by hand, but must be rammed with a machine made in the same manner as those for driving piles.

The method of ramming of wheel-cases, or any other sort, in which the charge is drove solid, is much the same as sky-rockets; for the same proportion may be observed in the ladle, and the same number of strokes given, according to their diameters, all cases being distinguished by their diameters. In this manner, a case, whose bore is equal to a rocket of 4 oz. is called a 4-oz. case, and that which is equal to an 8-oz rocket an 8-oz. case, and so on, according to the different rockets.

Having taught the method of ramming cases in moulds, we shall here say something concerning those filled without moulds; which method, for strong pasted cases, will do extremely well, and save the expence of making so many moulds. The reader must here observe, when he fills any sort of cases, to place the mould on a perpendicular block of wood, and not on any place that is hollow; for we have found by experience, that when cases were rammed on driving benches, which were formerly used, the works frequently miscarried, on account of the hollow resistance of the benches, which oft jarred and loosened the charge in the cases; but this accident never happens when the driving blocks are used (D).

When cases are to be filled without moulds, proceed thus. Have some nipples made of brass or iron, of several sorts and sizes, in proportion to the cases, and to screw or fix in the top of the driving block; when you have fixed in a nipple, make, at about $1\frac{1}{2}$ inch

(C) A copper scoop with a wooden handle.
(D) A piece of hard wood in the form of an anvil block.

inch from it, a ſquare hole in the block, 6 inches deep and 1 inch diameter; then have a piece of wood, 6 inches longer than the caſe intended to be filled, and 2 inches ſquare; on one ſide of it cut a groove almoſt the length of the caſe, whoſe breadth and depth muſt be ſufficient to cover near $\frac{1}{2}$ the caſe; then cut the other end to fit the hole in the block, but take care to cut it ſo that the groove may be of a proper diſtance from the nipple; this half mould being made and fixed tight in the block, cut, in another piece of wood nearly of the ſame length as the caſe, a groove of the ſame dimenſions as that in the fixed piece; then put the caſe on the nipple, and with a cord tie it and the 2 half-moulds together, and your caſe will be ready for filling.

The dimenſions of the above-deſcribed half-moulds are proportionable for caſes of 8 ounces; but notice muſt be taken, that they differ in ſize in proportion to the caſes.

Note, The clay, mentioned in this article, muſt be prepared after this manner: Get ſome clay, in which there is no ſtones nor ſand, and bake it in an oven till quite dry; then take it out and beat it to a powder, and afterwards ſift it through a common hair-ſieve, and it will be fit for uſe.

48. *Proportion of Mallets.*

The beſt wood for mallets is dry beech. If a perſon uſes a mallet of a moderate ſize, in proportion to the rocket, according to his judgment, and if the rocket ſucceeds, he may depend on the reſt, by uſing the ſame mallet; yet it will be neceſſary that caſes of different ſorts be drove with mallets of different ſizes.

The following proportion of the mallets for rockets of any ſize, from 1 oz. to 6 lb. may be obſerved; but as rockets are ſeldom made leſs than 1 oz. or larger than 6 lb. we ſhall leave the management of them to the curious; but all caſes under 1 oz. may be rammed with an oz. rocket mallet. Your mallets will ſtrike more ſolid, by having their handles turned out of the ſame piece as the head, and made in a cylindrical form. Let their dimenſions be worked by the diameters of the rockets: for example; let the thickneſs of the head be 3 diameters, and its length 4, and the length of the handle 5 diameters, whoſe thickneſs muſt be in proportion to the hand.

49. *Proportion of Sky-rockets, and manner of heading them.*

Fig. 13. repreſents a rocket complete without its ſtick, whoſe length from the neck is 5 diameters 1-6th: the caſes ſhould always be cut to this length after they are filled. M is the head, which is 2 diameters high, and 1 diameter 1-6th $\frac{1}{2}$ in breadth; N the cone or cap, whoſe perpendicular height muſt be 1 diameter 1-3d. Fig. 14. the collar to which the head is fixed: this is turned out of deal or any light wood, and its exterior diameter muſt be equal to the interior diameter of the head; 1-6th will be ſufficient for its thickneſs, and round the outſide edge muſt be a groove; the interior diameter of the collar muſt not be quite ſo wide as the exterior diameter of the rocket: when this is to be glued on the rocket, you muſt cut two or three rounds of paper off the caſe, which will make a ſhoulder for it to reſt upon. Fig. 15. a former for the head: two or three rounds of paper well paſted will be enough for the head, which, when rolled, put the collar on that part of the former marked O, which muſt fit the inſide of it; then, with the pinching cord pinch the bottom of the head into the groove, and tie it with ſmall twine. Fig. 16. a former for the cone. To make the caps, cut your paper in round pieces, equal in diameter to twice the length of the cone you intend to make; which pieces being cut into halves, will make two caps each, without waſting any paper; having formed the caps, paſte over each of them a thin white paper, which muſt be a little longer than the cone, ſo as to project about $\frac{1}{2}$ an inch below the bottom: this projection of paper, being notched and paſted, ſerves to faſten the cap to the head.

Of Moulds, Caſes, Mixture, Inſtruments, &c.

When you load the heads of your rockets, with ſtars, rains, ſerpents, crackers, ſcrolls, or any thing elſe, according to your fancy, remember always to put 1 ladle-full of meal-powder into each head, which will be enough to burſt the head, and diſperſe the ſtars, or whatever it contains: when the heads are loaded with any ſort of caſes, let their mouths be placed downwards; and after the heads are filled, paſte on the top of them a piece of paper, before you put on the caps. As the ſize of the ſtars often differ, it would be needleſs to give an exact number for each rocket; but this rule may be obſerved, that the heads may be nearly filled with whatever they are loaded.

50. *Decorations for Sky-rockets.*

Sky-rockets bearing the pre-eminence of all fire-works, it will not be improper to treat of their various kinds of decorations, which are directed according to fancy. Some are headed with ſtars of different ſorts, ſuch as tailed, brilliant, white, blue, and yellow ſtars, &c.; ſome with gold and ſilver rain; others with ſerpents, crackers, fireſcrolls, marrons; and ſome with ſmall rockets, and many other devices, as the maker pleaſes.

Dimenſions and poiſe of Rocket-ſticks.

Weight of the rocket.		Length of the ſtick.		Thickneſs at top.	Breadth at top.	Square at bottom.	Poiſe from the point of the cone.	
L.	oz.	F.	in.	Inches.	Inches.	Inches.	F.	in.
6	0	14	0	1,5	1,85	0,75	4	1,5
4	0	12	10	1,25	1,40	0,625	3	9,
2	0	9	4	1,125	1,	0,525	2	9,
1	0	8	2	0,725	0,80	0,375	2	1,
	8	6	6	0,5	0,70	0,25	1	10,5
	4	5	3	0,3750	0,55	0,35	1	8,5
	2	4	1	0,3	0,45	0,15	1	3,
	1	3	6	0,25	0,35	0,10	11	0,
	$\frac{1}{2}$	2	4	0,125	0,20	0,16	8	0,
	$\frac{1}{4}$	1	$10\frac{1}{2}$	0,1	0,15	0,5	5	0,5

The laſt column on the right, in the above table, expreſſes the diſtance from the top of the cone, where the ſtick, when tied on, ſhould balance the rocket, ſo as to ſtand in an equilibrium on one's finger or the edge of a knife. The beſt wood for the ſticks is dry deal, made thus. When you have cut and planed the ſticks according to the dimenſions given in the table, cut, on one of the flat ſides at the top, a groove the length of the rocket, and as broad as the ſtick will allow; then, on the oppoſite flat ſide, cut two notches for the cord, which ties on the rocket, to lie in; one of theſe notches muſt be near the top of the ſtick, and

Of Moulds, Cases, Mixture, Instruments, &c.

and the other facing the neck of the rockets; the diftance between thefe notches may eafily be known, for the top of the ftick fhould always touch the head of the rocket. When your rockets and fticks are ready, lay the rockets in the grooves in the fticks, and tie them on. Thofe who, merely for curiofity, may choofe to make rockets of different fizes, from thofe expreffed in the table of dimenfions, may find the length of their fticks, by making them for rockets, from ½ oz. to 1 lb. 60 diameters of the rocket long; and for rockets above 1 lb. 50 or 52 diameters will be a good length; their thicknefs at top may be about ½ a diameter, and their breadth a very little more; their fquare at bottom is generally equal to ½ the thicknefs at top. But although the dimenfions of the fticks be very nicely obferved, you muft depend only on their balance; for, without a proper counterpoife, your rockets, inftead of mounting perpendicularly, will take an oblique direction, and fall to the ground before they are burnt out.

51. *Boring Rockets which have been driven folid.*

Fig. 18. reprefents the plan of an apparatus, or lathe, for boring of rockets. A the large wheel, which turns the fmall one B, that works the rammer C: thefe rammers are of different fizes according to the rockets; they muft be of the fame diameter as the top of the bore intended, and continue that thicknefs a little longer than the depth of the bore required, and their points muft be like that of an augre: the thick end of each rammer muft be made fquare, and all of the fame fize, fo as to fit into one focket, wherein they are faftened by a fcrew D. E the guide for the rammer, which is made to move backwards and forwards: fo that, after you have marked the rammer 3½ diameters of the rocket from the point, fet the guide, allowing for the thicknefs of the fronts of the rocket boxes, and the neck and mouth of the rocket; fo that when the front of the large box is clofe to the guide, the rammer may not go too far up the charge. F, boxes for holding the rockets, which are made fo as to fit one in another; their fides muft be equal in thicknefs to the difference of the diameters of the rockets, and their interior diameters equal to the exterior diameters of the rockets. To prevent the rocket's turning round while boring, a piece of wood muft be placed againft the end of the box in the infide, and preffed againft the tail of the rocket; this will alfo hinder the rammer from forcing the rocket backwards. G, a rocket in the box. H, a box that flides under the rocket-boxes to receive the borings for the rockets, which fall through holes made on purpofe in the boxes; thefe holes muft be juft under the mouth of the rocket, one in each box, and all to correfpond with each other.

Fig. 19. is a front view of the large rocket-box. I, an iron plate, in which are holes of different fizes, through which the rammer paffes: this plate is faftened with a fcrew in the centre, fo that when you change the rammer, you turn the plate round, but always let the hole you are going to ufe be at the bottom: the fronts of the other boxes muft have holes in them to correfpond with thofe in the plate. K, the lower part of the large box; which is made to fit the infide of the lathe, that all the boxes may move quite fteady.

Fig. 20. is a perfpective view of the lathe. L, the guide for the rammer, which is fet by the fcrew at bottom.

Of Moulds, Cases, Mixture, Instruments

Fig. 21. A view of the front of the guide facing the rammer. M, an iron plate, of the fame dimenfions as that on the front of the box, and placed in the fame direction, and alfo to turn on a fcrew in the centre. N, the rocket-box which flides backwards and forwards: when you have fixed a rocket in the box, pufh it forwards againft the rammer; and when you think the fcoop of the rammer is full, draw the box back, and knock out the compofition: this you muft do till the rocket is bored, or it will be in danger of taking fire; and if you bore in a hurry, wet the end of the rammer now and then with oil to keep it cool.

Having bored a number of rockets, you muft have taps of different forts according to the rockets. Thefe taps are a little longer than the bore: but when you ufe them, mark them 3½ diameters from the point, allowing for the thicknefs of the rocket's neck; then, holding the rocket in one hand, you tap it with the other. One of thefe taps is reprefented by fig. 22. They are made in the fame proportion as the fixed piercers, and are hollowed their whole length.

52. *Hand Machine ufed for boring of Rockets inftead of a Lathe.*

Thefe fort of machines anfwer very well, though not fo expeditious as the lathes. But they are not fo expenfive to make, and they may be worked by one man; whereas the lathe will require three. Fig. 23. reprefents the machine. O, the rocket boxes, which are to be fixed, and not to flide as thofe in the lathe. PQ are guides for the rammers, that are made to flide together, as the rammer moves forward: the rammers for thefe forts of machines muft be made of a proper length, allowing for the thicknefs of the front of the boxes, and the length of the mouth and neck of the cafe; on the fquare end of thefe rammers muft be a round fhoulder of iron, to turn againft the outfide of the guide Q, by which means the guides are forced forwards. R, the ftock which turns the rammer, and while turning muft be preffed towards the rocket by the body of the man who works it; all the rammers are to be made to fit one ftock.

To make large Gerbes.

Pl. cccc

Fig. 1. reprefents a wooden former; fig. 2. a gerbe complete, with its foot or ftand. The cafes for gerbes are made very ftrong, on account of the ftrength of the compofition; which, when fired, comes out with great velocity: therefore, to prevent their burfting, the paper fhould be pafted, and the cafes made as thick at the top as at the bottom. They fhould alfo have very long necks, for this reafon; firft, that the particles of iron will have more time to be heated, by meeting with greater refiftance in getting out, than with a fhort neck, which would be burnt too wide before the charge be confumed, and fpoil the effect: fecondly, that with long necks the ftars will be thrown to a great height, and will not fall before they are fpent, or fpread too much; but, when made to perfection, will rife and fpread in fuch a manner as to form exactly a wheat-fheaf.

In the ramming of gerbes, there will be no need of a mould, the cafes being fufficiently ftrong to fupport themfelves.

oulds, Mix-, In-ents, themselves. But you are to be careful, before you begin to ram, to have a piece of wood made to fit in the neck; for if this be not done, the composition will fall into the neck, and leave a vacancy in the case, which will cause the case to burst so soon as the fire arrives at the vacancy. You must likewise observe, that the first ladle of charge, or second, if you think proper, be of some weak composition. When the case is filled, take out the piece of wood, and fill the neck with some slow charge. Gerbes are generally made about 6 diameters long, from the bottom to the top of the neck; their bore must be 1-5th narrower at top than at bottom. The neck S is 1-6th diameter and $\frac{1}{2}$ long. T, a wooden foot or stand, on which the gerbe is fixed. This may be made with a choak or cylinder 4 or 5 inches long to fit the inside of the case, or with a hole in it to put in the gerbe; both these methods will answer the same. Gerbes produce a most brilliant fire, and are very beautiful when a number of them are fixed in the front of a building or a collection of fireworks.

N. B. Gerbes are made by their diameters, and their cases at bottom $\frac{1}{4}$ thick. The method of finding the interior diameter of a gerbe is thus: Supposing you would have the exterior diameter of the case, when made, to be 5 inches, then, by taking 2-4ths for the sides of the case, there will remain $2\frac{1}{2}$ inches for the bore, which will be a very good size. These sort of gerbes should be rammed very hard.

54. *Small Gerbes, or white Fountains,*

May be made of 4 oz. 8 oz. or 1 lb. cases, pasted and made very strong, of what length you please: but, before you fill them, drive in clay one diameter of their orifice high; and when you have filled a case, bore a vent through the centre of the clay to the composition: the common proportion will do for the vent, which must be primed with a slow charge. These sort of cases, without the clay, may be filled with Chinese fire.

55. *To make Pasteboard and Paper Mortars.*

Plate CXXIX. Fig. 3. represents a former, and fig. 4. an elm foot, for the mortar. Fig. 5. represents a mortar complete: these mortars are best when made with pasteboard, well pasted before you begin; or, instead of paste, you may use glue. For a coehorn mortar, which is 4 inches 2-5ths diameter, roll the pasteboard on the former 1-6th of its diameter thick; and, when dry, cut one end smooth and even; then nail and glue it on the upper part of the foot: when done, cut off the pasteboard at top, allowing for the length of the mortar $2\frac{1}{2}$ diameters from the mouth of the powder-chamber; then bind the mortar round with a strong cord wetted with glue. U, the bottom part of the foot 1 diameter 2-3ds broad, and 1 diameter high; and that part which goes into the mortar is 2-3ds of its diameter high. W, is a copper chamber for powder, made in a conical form; and is 1-3d of the diameter wide, $1\frac{1}{2}$ of its own diameter long. In the centre of the bottom of this chamber, make a small hole a little way down the foot; this hole must be met by another of the same size, made in the side of the foot, as is shown in the figure. If these holes are made true, and a copper pipe fitted into both, the mortar when loaded will prime itself; for the powder will naturally fall to the bottom of the first hole; then by putting a bit of quick-match in the side hole, your mortar will be ready to be fired. Air-balloons, &c.

Mortars of $5\frac{1}{2}$, eight and ten inches diameter, may be made of paper or pasteboard, by the above method, and in the same proportion; but if larger, it will be best to have them made of brass. *N. B.* The copper chamber must have a small rim round its edge with holes in it, for screws to make it fast in the foot.

Sect. III. *To load Air-balloons, with the number of Stars, Serpents, Snakes, Rain-falls, &c. in Shells of each nature.*

56. *Mortars to throw Aigrettes, &c.*

When you fill your shells, you must first put in the serpents, rains, stars, &c. or whatever they are composed of; then the blowing powder; but the shells must not be quite filled. All those things must be put in at the fuze hole; but marrons being too large to go in at the fuze hole, must be put in before the inside shell be joined. When the shells are loaded, glue and drive in the fuzes very tight. For a coehorn balloon, let the diameter of the fuze hole be $\frac{7}{8}$ths of an inch; for a royal balloon, which is near $5\frac{1}{2}$ inches diameter, make the fuze hole 1 inch $\frac{1}{8}$th diameter; for an 8-inch balloon, 1 inch $\frac{3}{8}$ths; and for a 10-inch balloon, 1 inch $\frac{5}{8}$ths.

Air-balloons are divided into 4 sorts; viz. first, illuminated balloons; second, balloons of serpents; third, balloons of reports, marrons, and crackers; and fourth, compound balloons. The number and quantities of each article for the different shells are as follow.

Coehorn balloon illuminated.

	oz.
Meal powder	$1\frac{1}{4}$
Corn powder	$0\frac{1}{2}$
Powder for the mortar	2

Length of the fuze composition, $\frac{3}{4}$ths of an inch; 1 oz. drove or rolled stars, as many as will nearly fill the shell.

Coehorn balloon of serpents.

	oz.
Meal powder	$1\frac{1}{4}$
Corn powder	1
Powder for the mortar	$2\frac{1}{4}$

Length of the fuze composition $\frac{13}{16}$ths of an inch: half-ounce cases drove 3 diameters, and bounced 3 diameters, and half-ounce cases drove 2 diameters and bounced 4, of each an equal quantity, and as many of them as will fit in easily placed head to tail.

Coehorn balloons of crackers and reports.

	oz.
Meal powder	$1\frac{1}{4}$
Corn powder	$0\frac{3}{4}$
Powder for the mortar	2

Length of the fuze composition $\frac{3}{4}$ths of an inch. Reports 4, and crackers of 6 bounces as many as will fill the shell.

Compound coehorn balloons.

	oz.	dr.
Meal powder	1	4
Corn powder	0	12
Powder for the mortar	2	4

Length of the fuze composition $\frac{13}{16}$ths of an inch: $\frac{1}{2}$ ounce cases drove $3\frac{1}{2}$ diameters and bounced 2, 16; $\frac{1}{2}$ ounce cases drove 4 diameters and not bounced 10; blue strung stars, 10; rolled stars, as many as will complete the balloon.

Air-balloons, &c.

Royal balloons illuminated.

	oz.	dr.
Meal powder	1	8
Corn powder	0	12
Powder for the mortar	3	0

Length of the fuze compofition $\frac{15}{16}$ths of an inch; 2 ounce ftrung ftars, 34; rolled ftars, as many as the fhell will contain, allowing room for the fuze.

Royal balloons of ferpents.

	oz.	dr.
Meal powder	1	0
Corn powder	1	8
Powder for the mortar	3	8

Length of the fuze compofition 1 inch: 1 ounce-cafes drove $3\frac{1}{2}$ and 4 diameters, and bounced 2, of each an equal quantity, fufficient to load the fhell.

Royal balloons with crackers and marrons.

	oz.	dr.
Meal powder	1	8
Corn powder	1	4
Powder for firing the mortar	3	0

Length of the fuze compofition $\frac{14}{16}$ths of an inch; reports 12, and completed with crackers of 8 bounces.

Compound royal balloons.

	oz.	dr.
Meal powder	1	5
Corn powder	1	6
Powder for the mortar	3	12

Length of the fuze compofition 1 inch: $\frac{1}{2}$ ounce cafes drove and bounced 2 diameters, 8; 2 ounce cafes filled $\frac{3}{8}$ths of an inch with ftar compofition, and bounced 2 diameters, 8; filver rain-falls, 10; 2 ounce tailed ftars, 16; rolled brilliant ftars, 30. If this fhould not be fufficient to load the fhell, you may complete it with gold rain-falls.

Eight-inch balloons illuminated.

	oz.	dr.
Meal powder	2	8
Corn powder	1	4
Powder for the mortar	9	0

Length of the fuze compofition 1 inch $\frac{1}{8}$th: 2 ounce drove ftars, 48; 2 ounce cafes drove with ftar compofition $\frac{3}{8}$ths of an inch, and bounced 3 diameters, 12; and the balloon completed with 2 ounce drove brilliant ftars.

Eight-inch balloons of ferpents.

	oz.	dr.
Meal powder	2	0
Corn powder	2	0
Powder for the mortar	9	8

Length of the fuze compofition 1 inch $\frac{3}{16}$ths: 2 oz. cafes drove $1\frac{1}{3}$ diameter and bounced 2, and 1 ounce cafes drove 2 diameters and bounced $2\frac{1}{2}$, of each an equal quantity fufficient for the fhell.

N. B. The ftar-compofition drove in bounced cafes muft be managed thus: Firft, the cafes muft be pinched clofe at one end, then the corn-powder put in for a report, and the cafe pinched again clofe to the powder, only leaving a fmall vent for the ftar compofition, which is drove at top, to communicate to the powder at the bounce end.

Compound eight-inch balloons.

	oz.	dr.
Meal powder	2	8
Corn powder	1	12
Powder for the mortar	9	4

Length of the fuze compofition $\frac{7}{8}$th: 4 ounce cafes drove with ftar compofition $\frac{3}{8}$ths of an inch, and bounced 3 diameters, 16; 2 ounce tailed ftars, 16; 2 ounce drove brilliant ftars, 12; filver rain-falls, 20; 1 ounce drove blue ftars, 20; and 1 ounce cafes drove and bounced 2 diameters, as many as will fill the fhell.

Another of eight inches.

	oz.	dr.
Meal powder	2	8
Corn powder	1	12
Powder for the mortar	9	4

Length of the fuze compofition 1 inch $\frac{1}{8}$th: crackers of 6 reports, 10; gold rains, 14; 2 ounce cafes drove with ftar compofition $\frac{3}{8}$ths of an inch, and bounced 2 diameters, 16; 2 ounce tailed ftars, 16; 2 ounce drove brilliant ftars, 12; filver rains, 10; 1 ounce drove blue ftars, 20; and 1 oz. cafes drove with a brilliant charge 2 diameters and bounced 3, as many as the fhell will hold.

A compound ten-inch balloon.

	oz.	dr.
Meal powder	3	4
Corn powder	2	8
Powder for the mortar	12	8

Length of the fuze compofition $\frac{15}{16}$ths of an inch: 1 ounce cafes drove and bounced 3 diameters, 16. Crackers of 8 reports, 12; 4 ounce cafes drove $\frac{1}{2}$ inch with ftar-compofition, and bounced 2 diameters, 14; 2 ounce cafes drove with brilliant fire $1\frac{1}{4}$ diameter, and bounced 2 diameters, 16: 2 ounce drove brilliant ftars, 30: 2 ounce drove blue ftars, 3; gold rains, 20; filver rains, 20. After all thefe are put in, fill the remainder of the cafe with tailed and rolled ftars.

Ten-inch balloons of three charges.

	oz.	dr.
Meal powder	3	0
Corn powder	3	2
Powder for the mortar	13	0

Length of the fuze compofition 1 inch. The fhell muft be loaded with 2 ounce cafes, drove with ftar compofition $\frac{1}{4}$th of an inch, and on that 1 diameter of gold fire, then bounced 3 diameters; or with 2 ounce cafes firft filled 1 diameter with gold fire, then $\frac{1}{4}$th of an inch with ftar compofition, and on that $1\frac{1}{4}$th diameter of brilliant fire. Thefe cafes muft be well fecured at top of the charge, left they fhould take fire at both ends; but their necks muft be larger than the common proportion.

57. *To make Balloon Fuzes.*

Fuzes for air-balloons are fometimes turned out of dry beech, with a cup at top to hold the quick-match, as you fee in fig. 5. but if made with pafted paper, they will do as well: the diameter of the former for fuzes for coehorn balloons muft be $\frac{1}{2}$ an inch; for a royal fuze, $\frac{5}{8}$ths of an inch; for an 8-inch fuze, $\frac{3}{4}$ths of an inch; and for a 10-inch fuze, $\frac{7}{8}$ths of an inch. Having rolled your cafes, pinch and tie them almoft clofe at one end; then drive them down, and let them dry. Before you begin to fill them, mark on the outfide of the cafe the length of the charge required, allowing for the thicknefs of the bottom; and when you have rammed in the compofition, take two pieces of quick-match about 6 inches long, and lay one end of each on the charge, and then a little meal-powder, which ram down hard; the loofe ends of the match double up into the top of the fuze, and cover it with a paper cap to keep it dry. When you put the fhells in the mortars, uncap the fuzes, and pull out the loofe ends of the match, and let them hang on the fides of the balloons. The ufe of the match is, to receive the fire from the powder in the chamber of the mortar, in order to light the fuze: the fhell being put in the mortar with the fuze uppermoft, and exactly in the centre, fprinkle over it a little meal-powder, and it will be ready to be fired.

Fuzes

Air-balloons, &c.

Fuzes made of wood muſt be longer than thoſe of paper, and not bored quite through, but left ſolid about ½ an inch at bottom; and when you uſe them, ſaw them off to a proper length, meaſuring the charge from the cup at top.

58. *Tourbillons.*

Having filled ſome caſes within about $1\frac{1}{2}$ diameter, drive in a ladleful of clay; then pinch their ends cloſe, and drive them down with a mallet. When done, find the centre of gravity of each caſe; where you nail and tie a ſtick, which ſhould be ½ an inch broad at the middle, and run a little narrower to the ends: theſe ſticks muſt have their ends turned upwards, ſo that the caſes may turn horizontally on their centres: at the oppoſite ſides of the caſes, at each end, bore a hole cloſe to the clay with a gimblet, the ſize of the neck of a common caſe of the ſame nature; from theſe holes draw a line round the caſe, and at the under part of the caſe bore a hole with the ſame gimblet, within ½ diameter of each line towards the centre; then from one hole to the other draw a right line. This line divide into three equal parts; and at X and Y (fig. 6.) bore a hole; then from theſe holes to the other two lead a quick-match, over which paſte a thin paper. Fig. 7. repreſents a tourbillon as it ſhould lie to be fired, with a leader from one ſide-hole A to the other B. When you fire tourbillons, lay them on a ſmooth table, with their ſticks downwards, and burn the leader thro' the middle with a port-fire. They ſhould ſpin three or four ſeconds on the table before they riſe, which is about the time the compoſition will be burning from the ſide-holes to thoſe at bottom.

To tourbillons may be fixed reports in this manner: In the centre of the caſe at top make a ſmall hole, and in the middle of the report make another; then place them together, and tie on the report, and with a ſingle paper ſecure it from fire: this done, your tourbillon is completed. By this method you may fix on tourbillons ſmall cones of ſtars, rains, &c. but be careful not to load them too much. One-eighth of an inch will be enough for the thickneſs of the ſticks, and their length equal to that of the caſes.

59. *To make Mortars to throw Aigrettes, and to load and fire them.*

Mortars to throw aigrettes are generally made of paſteboard, of the ſame thickneſs as balloon mortars, and $2\frac{1}{2}$ diameters long in the inſide from the top of the foot: the foot muſt be made of elm without a chamber, but flat at top, and in the ſame proportion as thoſe for balloon mortars; theſe mortars muſt alſo be bound round with a cord as before-mentioned: ſometimes 8 or 9 of theſe mortars, of about three or four inches diameter, are bound all together, ſo as to appear but one: but when they are made for this purpoſe, the bottom of the foot muſt be of the ſame diameter as the mortars, and only ½ diameter high. Your mortars being bound well together, fix them on a heavy ſolid block of wood. To load theſe mortars, firſt put on the inſide bottom of each a piece of paper, and on it ſpread $1\frac{1}{2}$ oz. of meal and corn powder mixed; then tie your ſerpents up in parcels with quick-match, and put them in the mortar with their mouths downwards; but take care the parcels do not fit too tight in the mortars, and that all the ſerpents have been well primed with powder wetted with ſpirit of wine. On the top of the ſerpents in each mortar lay ſome paper or tow; then carry a leader from one mortar to the other all round, and then from all the outſide mortars into that in the middle: theſe leaders muſt be put between the caſes and the ſides of the mortar, down to the powder at bottom: in the centre of the middle mortar fix a fire-pump, or brilliant fountain, which muſt be open at bottom, and long enough to project out of the mouth of the mortar; then paſte paper on the tops of all the mortars.

Mortars thus prepared are called a *neſt of ſerpents*, as repreſented by fig. 8. When you would fire theſe mortars, light the fire-pump C, which when conſumed will communicate to all the mortars at once by means of the leaders. For mortars of 6, 8, or 10 inches diameter, the ſerpents ſhould be made in 1 and 2 ounce caſes 6 or 7 inches long, and fired by a leader brought out of the mouth of the mortar, and turned down the outſide, and the end of it covered with paper, to prevent the ſparks of the other works from ſetting it on fire. For a ſix-inch mortar, let the quantity of powder for firing be 2 oz.; for an 8-inch, $2\frac{1}{4}$ oz.; and for a 10-inch, $3\frac{1}{4}$ oz. Care muſt be taken in theſe, as well as ſmall mortars, not to put the ſerpents in too tight, for fear of burſting the mortars. Theſe mortars may be loaded with ſtars, crackers, &c.

If the mortars, when loaded, are ſent to any diſtance, or liable to be much moved, the firing powder ſhould be ſecured from getting amongſt the ſerpents, which would endanger the mortars, as well as hurt their performance. To prevent which, load your mortars thus: Firſt put in the firing powder, and ſpread it equally about; then cut a round piece of blue touch-paper, equal to the exterior diameter of the mortar, and draw on it a circle equal to the interior diameter of the mortar, and notch it all round as far as that circle; then paſte that part which is notched, and put it down the mortar cloſe to the powder, and ſtick the paſted edge to the mortar: this will keep the powder always ſmooth at bottom, ſo that it may be moved or carried anywhere without receiving damage. The large ſingle mortars are called *pots des aigrettes*.

60. *Making, loading, and firing, of Pots des Brins.*

Theſe are formed of paſteboard, and muſt be rolled pretty thick. They are uſually made 3 or 4 inches diameter, and 4 diameters long; and pinched with a neck at one end, like common caſes. A number of theſe are placed on a plank thus: Having fixed on a plank two rows of wooden pegs, cut in the bottom of the plank a groove the whole length under each row of pegs; then, through the centre of each peg, bore a hole down to the groove at bottom, and on every peg fix and glue a pot, whoſe mouth muſt fit tight on the peg: through all the holes run a quick-match, one end of which muſt go into the pot, and the other into the groove, which muſt have a match laid in it from end to end, and covered with paper, ſo that when lighted at one end it may diſcharge the whole almoſt inſtantaneouſly: in all the pots put about 1 oz. of meal and corn powder; then in ſome put ſtars, and others rains, ſnakes, ſerpents, crackers, &c. when they are all loaded, paſte paper over their mouths. Two or three hundred of theſe pots being fired together make a very pretty ſhow, by affording ſo great a variety of fires. Fig. 9. is a range of pots des brins, with a leader A, by which they are fired.

Air-balloons, &c.

61. *Pots des Sauciſſons*,

Are generally fired out of large mortars without chambers, the ſame as thoſe for aigrettes, only ſomewhat ſtronger. Sauciſſons are made of 1 and 2 ounce caſes, 5 or 6 inches long, and choaked in the ſame manner as ſerpents. Half the number which the mortar contains muſt be drove $1\frac{1}{2}$ diameter with compoſition, and the other half two diameters, ſo that when fired they may give two volleys of reports. But if the mortars are very ſtrong, and will bear a ſufficient charge to throw the ſauciſſons very high, you may make three volleys of reports, by dividing the number of caſes into three parts, and making a difference in the height of the charge. After they are filled, pinch and tie them at top of the charge almoſt cloſe; only leaving a ſmall vent to communicate the fire to the upper part of the caſe, which muſt be filled with corn-powder very near the top; then pinch the end quite cloſe, and tie it: after this is done, bind the caſe very tight with waxed packthread, from the choak at top of the compoſition to the end of the caſe; this will make the caſe very ſtrong in that part, and cauſe the report to be very loud. Sauciſſons ſhould be rolled a little thicker of paper than the common proportion. When they are to be put in the mortar, they muſt be primed in their mouths, and fired by a caſe of brilliant fire fixed in their centre.

The charge for theſe mortars ſhould be $\frac{1}{5}$th or $\frac{1}{6}$th more than for *pots des aigrettes* of the ſame diameter.

Sect. IV. *Different kinds of Rockets, with their Appendages and Combinations.*

62. *To fix one Rocket on the top of another.*

When ſky-rockets are thus managed, they are called *towering rockets*, on account of their mounting ſo very high. Towering rockets are made after this manner: Fix on a pound-rocket a head without a collar; then take a four ounce rocket, which may be headed or bounced, and rub the mouth of it with meal-powder wetted with ſpirit of wine: when done, put it in the head of the large rocket with its mouth downwards; but before you put it in, ſtick a bit of quick-match in the hole of the clay of the pound-rocket, which match ſhould be long enough to go a little way up the bore of the ſmall rocket, to fire it when the large is burnt out, the 4 ounce rocket being too ſmall to fill the head of the other, roll round it as much tow as will make it ſtand upright in the centre of the head: the rocket being thus fixed, paſte a ſingle paper round the opening of the top of the head of the large rocket. The large rocket muſt have only half a diameter of charge rammed above the piercer; for, if filled to the uſual height, it would turn before the ſmall one takes fire, and entirely deſtroy the intended effect: when one rocket is headed with another, there will be no occaſion for any blowing powder; for the force with which it ſets off will be ſufficient to diſengage it from the head of the firſt fired rocket. The ſticks for theſe rockets muſt be a little longer than for thoſe headed with ſtars, rains, &c.

63. *Caduceus Rockets*,

In riſing, form two ſpiral lines, or double worm, by reaſon of their being placed obliquely, one oppoſite the other; and their counterpoiſe in their centre, which cauſes them to riſe in a vertical direction. Rockets for this purpoſe muſt have their ends choaked cloſe, without either head or bounce, for a weight at top would be a great obſtruction to their mounting; though I have known them ſometimes to be bounced, but then they did not riſe ſo high as thoſe that were not; nor do any caduceus rockets aſcend ſo high as ſingle, becauſe of their ſerpentine motion, and likewiſe the reſiſtance of air, which is much greater than two rockets of the ſame ſize would meet with if fired ſingly.

Rockets, &c.

By 2d fig. 9. you ſee the method of fixing theſe rockets: the ſticks for this purpoſe muſt have all their ſides alike, which ſides ſhould be equal to the breadth of a ſtick proper for a ſky-rocket of the ſame weight as thoſe you intend to uſe, and to taper downwards as uſual, long enough to balance them, one length of a rocket from the croſs ſtick; which muſt be placed from the large ſtick 6 diameters of one of the rockets, and its length 7 diameters; ſo that each rocket, when tied on, may form with the large ſtick an angle of 60 degrees. In tying on the rockets, place their heads on the oppoſite ſides of the croſs ſtick, and their ends on the oppoſite ſides of the long ſtick; then carry a leader from the mouth of one into that of the other. When theſe rockets are to be fired, ſuſpend them between two hooks or nails, then burn the leader through the middle, and both will take fire at the ſame time. Rockets of 1 lb. are a good ſize for this uſe.

64. *Honorary Rockets*,

Are the ſame as ſky-rockets, except that they carry no head nor report, but are cloſed at top, on which is fixed a cone; then on the caſe, cloſe to the top of the ſtick, you tie on a 2 ounce caſe, about 5 or 6 inches long, filled with a ſtrong charge, and pinched cloſe at both ends; then in the reverſe ſides, at each end, bore a hole in the ſame manner as in tourbillons; from each hole carry a leader into the top of the rocket. When the rocket is fired, and arrived to its proper height, it will give fire to the caſe at top; which will cauſe both rocket and ſtick to ſpin very faſt in their return, and repreſent a worm of fire deſcending to the ground.

There is another method of placing the ſmall caſe, which is by letting the ſtick riſe a little above the top of the rocket, and tying the caſe to it, ſo as to reſt on the rocket: theſe rockets have no cones.

There is alſo a third method by which they are managed, which is thus: In the top of a rocket fix a piece of wood, in which drive a ſmall iron ſpindle; then make a hole in the middle of the ſmall caſe, through which put the ſpindle: then fix on the top of it a nut, to keep the caſe from falling off; when this is done, the caſe will turn very faſt, without the rocket: but this method does not anſwer ſo well as either of the former.

Fig. 10. is the honorary rocket complete. The beſt ſized rockets for this purpoſe are thoſe of 1 lb.

65. *To divide the tail of a Sky-rocket ſo as to form an Arch when aſcending.*

Having ſome rockets made, and headed according to fancy, and tied on their ſticks; get ſome ſheet tin, and cut it into round pieces about 3 or 4 inches diameter; then on the ſtick of each rocket, under the mouth of the caſe, fix one of theſe pieces of tin 16 inches from the rocket's neck, and ſupport it by a wooden bracket,

as ſtrong as poſſible: the uſe of this is, that when the rocket is aſcending the fire will play with great force on the tin, which will divide the tail in ſuch a manner that it will form an arch as it mounts, and will have a very good effect when well managed: if there is a ſhort piece of port-fire, of a ſtrong charge, tied to the end of the ſtick, it will make a great addition; but this muſt be lighted before you fire the rocket.

66. *To make ſeveral Sky-rockets riſe in the ſame direction, and equally diſtant from each other.*

Take ſix, or any number of ſky-rockets, of what ſize you pleaſe, then cut ſome ſtrong packthread into pieces of 3 or 4 yards long, and tie each end of theſe pieces to a rocket in this manner: Having tied one end of your packthread round the body of one rocket, and the other end to another, take a ſecond piece of packthread and make one end of it faſt to one of the rockets already tied, and the other end to a third rocket, ſo that all the rockets, except the two outſide, will be faſtened to two pieces of packthread: the length of thread from one rocket to the other may be what the maker pleaſes; but the rockets muſt be all of a ſize, and their heads filled with the ſame weight of ſtars, rains, &c.

Having thus done, fix in the mouth of each rocket a leader of the ſame length; and when you are going to fire them, hang them almoſt cloſe; then tie the ends of the leaders together, and prime them: this prime being fired, all the rockets will mount at the ſame time, and divide as far as the ſtrings will allow; which diviſion they will keep, provided they are all rammed alike, and well made. They are called by ſome *chained rockets.*

67. *Signal Sky-rockets*

Are made of ſeveral kinds, according to the different ſignals intended to be given; but in artificial fireworks, two ſorts are only uſed, which are one with reports and the other without; but thoſe for the uſe of the navy and army are headed with ſtars, ſerpents, &c.—Rockets which are to be bounced muſt have their caſes made 1½ or 2 diameters longer than the common proportion; and after they are filled, drive in a double quantity of clay, then bounce and pinch them after the uſual manner, and fix on each a cap.

Signal ſky-rockets without bounces, are only ſky-rockets cloſed and capped: theſe are very light, therefore do not require ſuch heavy ſticks as thoſe with loaded heads; for which reaſon you may cut one length of the rocket off the ſtick, or elſe make them thinner.

Signal rockets with reports are fired in ſmall flights; and often both theſe, and thoſe without reports, are uſed for a ſignal to begin firing a collection of works.

68. *To fix a Sky-rocket with its Stick on the top of another.*

Rockets thus managed make a pretty appearance, by reaſon of a freſh tail being ſeen when the ſecond rocket takes fire, which will mount to a great height. The method of preparing theſe rockets is thus: Having filled a two-pounder, which muſt be filled only half a diameter above the piercer, and its head not more than 10 or 12 ſtars; the ſtick of this rocket muſt be made a little thicker than common; and when made, cut it in half the flat way, and in each half make a groove, ſo that when the two halves are joined, the hollow made by the grooves may be large enough to hold the ſtick of a half-pound rocket; which rocket make and head as uſual: put the ſtick of this rocket into the hollow of the large one, ſo far that the mouth of the rocket may reſt on the head of the two-pounder; from whoſe head carry a leader into the mouth of the ſmall rocket; which being done, your rockets will be ready for firing.

2d 68. *To fix two or more Sky-rockets on one Stick.*

Two, three, or ſix ſky-rockets, fixed on one ſtick, and fired together, make a grand and beautiful appearance; for the tails of all will ſeem but as one of an immenſe ſize, and the breaking of ſo many heads at once will reſemble the burſting of an air-balloon. The management of this device requires a ſkilful hand; but if the following inſtructions be well obſerved, even by thoſe who have not made a great progreſs in this art, there will be no doubt of the rockets having the deſired effect.

Rockets for this purpoſe muſt be made with the greateſt exactneſs, all rammed by the ſame hand, in the ſame mould, and out of the ſame proportion of compoſition; and after they are filled and headed, muſt all be of the ſame weight. The ſtick muſt alſo be well made (and proportioned) to the following directions: firſt, ſuppoſing your rockets to be ¼ pounders, whoſe ſticks are 6 feet 6 inches long, then if 2, 3, or 6 of theſe are to be fixed on 1 ſtick, let the length of it be 9 feet 9 inches; then cut the top of it into as many ſides as there are rockets, and let the length of each ſide be equal to the length of 1 of the rockets without its head; and in each ſide cut a groove (as uſual); then from the grooves plane it round, down to the bottom, where its thickneſs muſt be equal to half the top of the round part. As their thickneſs cannot be exactly aſcertained, we ſhall give a rule which generally anſwers for any number of rockets above two: the rule is this; that the ſtick at top muſt be thick enough, when the grooves are cut, for all the rockets to lie, without preſſing each other, though as near as poſſible.

When only 2 rockets are to be fixed on one ſtick, let the length of the ſtick be the laſt given proportion, but ſhaped after the common method, and the breadth and thickneſs double the uſual dimenſions. The point of poiſe muſt be in the uſual place (let the number of rockets be what they will): if ſticks made by the above directions ſhould be too heavy, plane them thinner; and if too light, make them thicker; but always make them of the ſame length.

When more than two rockets are tied on one ſtick, there will be ſome danger of their flying up without the ſtick, unleſs the following precaution is taken: For caſes being placed on all ſides, there can be no notches for the cord which ties on the rockets to lie in; therefore, inſtead of notches, drive a ſmall nail in each ſide of the ſtick, between the necks of the caſes: and let the cord, which goes round their necks, be brought cloſe under the nails; by this means the rockets will be as ſecure as when tied on ſingly. Your rockets being thus fixed, carry a quick-match, without a pipe, from the mouth of one rocket to the other; this match being lighted will give fire to all at once.

Though the directions already given may be ſufficient for theſe rockets, we ſhall here add an improvement on a very eſſential part of this device, which is, that of hanging the rockets to be fired; for before the

Rockets, &c.

following method was hit upon, many eſſays proved unſucceſsful. Inſtead, therefore, of the old and common manner of hanging them on nails or hooks, make uſe of this contrivance: Have a ring made of ſtrong iron wire, large enough for the ſtick to go in as far as the mouths of the rockets; then let this ring be ſupported by a ſmall iron, at ſome diſtance from the poſt or ſtand to which it is fixed; then have another ring, fit to receive and guide the ſmall end of the ſtick. Rockets thus ſuſpended will have nothing to obſtruct their fire; but when they are hung on nails or hooks, in ſuch a manner that ſome of their mouths are againſt or upon a rail, there can be no certainty of their riſing in a vertical direction.

69. *To fire Sky-rockets without Sticks.*

You muſt have a ſtand, of a block of wood, a foot diameter, and make the bottom flat, ſo that it may ſtand ſteady: in the centre of the top of this block draw a circle $2\frac{1}{2}$ inches diameter, and divide the circumference of it into three equal parts; then take 3 pieces of thick iron wire, each about 3 feet long, and drive them into the block, 1 at each point made on the circle; when theſe wires are drove in deep enough to hold them faſt and upright, ſo that the diſtance from one to the other is the ſame at top as at bottom, the ſtand is complete.

The ſtand being thus made, prepare your rockets thus: Take ſome common ſky-rockets, of any ſize, and head them as you pleaſe; then get ſome balls of lead, and tie to each a ſmall wire 2 or $2\frac{1}{2}$ feet long, and the other end of each wire tie to the neck of a rocket. Theſe balls anſwer the purpoſe of ſticks when made of a proper weight, which is about 2-3ds the weight of the rocket; but when they are of a proper ſize, they will balance the rocket in the ſame manner as a ſtick, at the uſual point of poiſe. To fire theſe, hang them, one at a time, between the tops of the wires, letting their heads reſt on the point of the wires, and the balls hang down between them: if the wires ſhould be too wide for the rockets, preſs them together till they fit; and if too cloſe, force them open; the wires for this purpoſe muſt be ſoftened, ſo as not to have any ſpring, or they will not keep their poſition when preſſed cloſe or opened.

70. *Rain-falls and Stars for Sky-rockets, Double and Single.*

Gold and ſilver rain compoſitions are drove in caſes that are pinched quite cloſe at one end: if you roll them dry, 4 or 5 rounds of paper will be ſtrong enough; but if they are paſted, 3 rounds will do; and the thin ſort of cartridge-paper is beſt for thoſe ſmall caſes, which in rolling you muſt not turn down the inſide edge as in other caſes, for a double edge would be too thick for ſo ſmall a bore. The moulds for rain-falls ſhould be made of braſs, and turned very ſmooth in the inſide; or the caſes, which are ſo very thin, would tear in coming out; for the charge muſt be drove in tight; and the better the caſe fits the mould, the more driving it will bear. Theſe moulds have no nipple, but inſtead thereof they are made flat. As it would be very tedious and troubleſome to ſhake the compoſition out of ſuch ſmall ladles as are uſed for theſe caſes, it will be neceſſary to have a funnel made of thin tin, to fit on the top of the caſe, by the help of which you may fill them very faſt. For ſingle rain-falls for 4 oz. rockets, let the diameter of the former be 2-16ths of an inch, and the length of the caſe 2 inches; for 8 oz. rockets, 4-16ths and 2 diameters of the rocket long; for 1 lb. rockets, 5-16ths, and 2 diameters of the rocket long; for 2 lb. rockets, 5-16ths, and $3\frac{1}{2}$ inches long; for 4 lb. rockets, 6-16ths, and $4\frac{1}{2}$ inches long; and for 6-pounders, 7-16ths diameter, and 5 inches long.

Of double rain-falls there are two ſorts. For example, ſome appear firſt like a ſtar, and then as rain; and ſome appear firſt as rain, and then like a ſtar. When you would have ſtars firſt, you muſt fill the caſes, within $\frac{1}{2}$ inch of the top, with rain-compoſition, and the remainder with ſtar-compoſition; but when you intend the rain ſhould be firſt, drive the caſe $\frac{1}{2}$ an inch with ſtar-compoſition, and the reſt with rain. By this method may be made many changes of fire; for in large rockets you may make them firſt burn as ſtars, then rain, and again as ſtars; or they may firſt ſhow rain, then ſtars, and finiſh with a report; but when they are thus managed, cut open the firſt rammed end, after they are filled and bounced, at which place prime them. The ſtar-compoſition for this purpoſe muſt be a little ſtronger than for rolled ſtars.

Strung ſtars. Firſt take ſome thin paper, and cut it into pieces of $1\frac{1}{2}$ inch ſquare, or thereabouts; then on each piece lay as much dry ſtar-compoſition as you think the paper will eaſily contain; then twiſt up the paper as tight as you can; when done, rub ſome paſte on your hands, and roll the ſtars between them; then ſet them to dry: your ſtars being thus made, get ſome flax or fine tow, and roll a little of it over each ſtar; then paſte your hands and roll the ſtars as before, and ſet them again to dry; when they are quite dry, with a piercer make a hole through the middle of each, into which run a cotton quick-match, long enough to hold 10 or 12 ſtars at 3 or 4 inches diſtance: but any number of ſtars may be ſtrung together by joining the match.

Tailed ſtars. Theſe are called *tailed ſtars*, becauſe there are a great number of ſparks iſſue from them, which repreſent a tail like that of a comet. Of theſe there are two ſorts; which are *rolled*, and *drove*: when rolled, they muſt be moiſtened with a liquor made of half a pint of ſpirit of wine and half a gill of thin ſize, of this as much as will wet the compoſition enough to make it roll eaſy; when they are rolled, ſift meal-powder over them, and ſet them to dry.

When tailed ſtars are drove, the compoſition muſt be moiſtened with ſpirit of wine only, and not made ſo wet as for rolling: 1 and 2 oz. caſes, rolled dry, are beſt for this purpoſe; and when they are filled, unroll the caſe within 3 or 4 rounds of the charge, and all that you unroll cut off; then paſte down the looſe edge: 2 or 3 days after the caſes are filled, cut them in pieces 5 or 6-8ths of an inch in length: then melt ſome wax, and dip one end of each piece into it, ſo as to cover the compoſition: the other end muſt be rubbed with meal-powder wetted with ſpirit of wine.

Drove ſtars. Caſes for drove ſtars are rolled with paſte, but are made very thin of paper. Before you begin to fill them, damp the compoſition with ſpirit of wine that has had ſome camphor diſſolved in it: you may ram them indifferently hard, ſo that you do not break or ſack the caſe; to prevent which, they ſhould

fhould fit tight in the mould. They are drove in cafes of feveral fizes, from 8 drams to 4 oz. When they are filled in $\frac{1}{2}$ oz. cafes, cut them in pieces of $\frac{3}{4}$ of an inch long; if 1 oz. cafes, cut them in pieces of 1 inch; if 2 oz. cafes, cut them in pieces of $1\frac{1}{4}$ inch long; and if 4 oz. cafes, cut them in pieces of $1\frac{1}{2}$ inch long: having cut your ftars of a proper fize, prime both ends with wet meal-powder. Thefe ftars are feldom put in rockets, they being chiefly intended for air-balloons, and drove in cafes, to prevent the compofition from being broke by the force of the blowing powder in the fhell.

Rolling ftars are commonly made about the fize of a mufket-ball; though they are rolled of feveral fizes, from the bignefs of a piftol-ball to 1 inch diameter; and fometimes very fmall, but are then called *fparks*. Great care muft be taken in making ftars, firft, that the feveral ingredients are reduced to a fine powder; fecondly, that the compofition is well worked and mixed. Before you begin to roll, take about a pound of compofition, and wet it with the following liquid, enough to make it ftick together and roll eafy: Spirit of wine 1 quart, in which diffolve $\frac{1}{4}$ of an ounce of ifinglafs. If a great quantity of compofition be wetted at once, the fpirit will evaporate, and leave it dry, before you can roll it into ftars: having rolled up one proportion, fhake the ftars in meal-powder, and fet them to dry, which they will do in 3 or 4 days; but if you fhould want them for immediate ufe, dry them in an earthen pan over a flow heat, or in an oven. It is very difficult to make the ftars all of an equal fize when the compofition is taken up promifcuoufly with the fingers; but by the following method they may be made very exact: When the mixture is moiftened properly, roll it on a flat fmooth ftone, and cut it into fquare pieces, making each fquare large enough for the ftars you intend. There is another method ufed by fome to make ftars, which is by rolling the compofition in long pieces, and then cutting off the ftar, fo that each ftar will be of a cylindrical form: but this method is not fo good as the former; for, to make the compofition roll this way, it muft be made very wet, which makes the ftars heavy, as well as weakens them. All ftars muft be kept as much from air as poffible, otherwife they will grow weak and bad.

71. *Scrolls for Sky-rockets.*

Cafes for fcrolls fhould be made 4 or 5 inches in length, and their interior diameter 3-8ths of an inch: one end of thefe cafes muft be pinched quite clofe, before you begin to fill; and when filled, clofe the other end: then in the oppofite fides make a fmall hole at each end, to the compofition, in the fame manner as in tourbillons; and prime them with wet meal-powder. You may put in the head of a rocket as many of thefe cafes as it will contain: being fired they turn very quick in the air, and form a fcroll or fpiral line. They are generally filled with a ftrong charge, as that of ferpents or brilliant fire.

72. *Swarmers, or fmall Rockets.*

Rockets that go under the denomination of *fwarmers*, are thofe from 2 oz. downwards. Thefe rockets are fired fometimes in flights, and in large waterworks, &c. Swarmers of 1 and 2 oz. are bored, and made in the fame manner as large rockets, except that, when headed, their heads muft be put on without a collar: the number of ftrokes for driving 1 oz. muft be 8, and for 2 oz. 12.

Rockets, &c.

All rockets under 1 oz. are not bored, but muft be filled to the ufual height with compofition, which generally confifts of fine meal-powder 4 oz. and charcoal or fteel-duft 2 drams: the number of ftrokes for ramming thefe fmall fwarmers is not material, provided they are rammed true, and moderately hard. The necks of unbored rockets muft be in the fame proportion as in common cafes.

73. *Stands for Sky-rockets.*

Care muft be taken, in placing the rockets when they are to be fired, to give them a vertical direction at their firft fetting out; which may be managed thus. Have two rails of wood, of any length, fupported at each end by a perpendicular leg, fo that the rails be horizontal, and let the diftance from one to the other be almoft equal to the length of the fticks of the rockets intended to be fired; then in the front of the top rail drive fquare hooks at 8 inches diftance, with their points turning fidewife, fo that when the rockets are hung on them, the points will be before the fticks and keep them from falling or being blown off by the wind: in the front of the rail at bottom muft be ftaples, drove perpendicular under the hooks at top; through thefe ftaples put the fmall ends of the rocket-fticks. Rockets are fired by applying a lighted port-fire to their mouths.

N. B. When fky-rockets are made to perfection, and fired, they will ftand 2 or 3 feconds on the hook before they rife, and then mount up brifkly, with a fteady motion, carrying a large tail from the ground all the way up, and juft as they turn break and difperfe the ftars.

74. *Girandole Chefts for Flights of Rockets.*

Thefe are generally compofed of four fides, of equal dimenfions; but may be made of any diameter, according to the number of rockets defigned to be fired; its height muft be in proportion to the rockets, but muft always be a little higher than the rockets with their fticks. When the fides are joined, fix in the top, as far down the cheft as the length of one of the rockets with its cap on. In this top, make as many fquare or round holes to receive the rocket-fticks, as you intend to have rockets; but let the diftance between them be fufficient for the rockets to ftand without touching one another; then from one hole to another cut a groove large enough for a quick-match to lie in: the top being thus fixed, put in the bottom, at about $1\frac{1}{2}$ foot diftance from the bottom of the cheft; in this bottom muft be as many holes as in the top, and all to correfpond; but thefe holes need not be fo large as thofe in the top.

To prepare your cheft, you muft lay a quick-match, in all the grooves, from hole to hole; then take fome fky-rockets, and rub them in the mouth with wet meal-powder, and put a bit of match up the cavity of each; which match muft be long enough to hang a little below the mouth of the rocket. Your rockets and cheft being prepared according to the above directions, put the fticks of the rockets through the holes in the top and bottom of the cheft, fo that their mouths may reft on the quick-match in the grooves: by which all the rockets will be fired at once; for by giving fire to any

 part

Rockets, &c.

part of the match, it will communicate to all the rockets in an instant. As it would be rather troublesome to direct the sticks from the top to the proper holes in the bottom, it will be necessary to have a small door in one of the sides, which, when opened, you may see how to place the sticks. Flights of rockets being seldom set off at the beginning of any fire-works, they are in danger of being fired by the sparks from wheels, &c. therefore, to preserve them, a cover should be made to fit on the chest, and the door in the side kept shut.

75. *Serpents or Snakes for Pots of Aigrettes, small Mortars, Sky-rockets, &c.*

Serpents for this use are made from $2\frac{1}{2}$ inches to 7 inches long, and their formers from 3-16ths to 5-8ths of an inch diameter; but the diameter of the cases must always be equal to 2 diameters of the former. They are rolled and choaked like other cases, and filled with composition from 5-8ths of an inch to $1\frac{1}{2}$ inch high, according to the size of the mortars or rockets they are designed for; and the remainder of the cases bounced with corn-powder, and afterwards their ends pinched and tied close: before they are used, their mouths must be primed with wet meal-powder.

76. *Leaders, or Pipes of Communication.*

The best paper for leaders is elephant; which you cut into long slips 2 or 3 inches broad, so that they may go 3 or 4 times round the former, but not more: when they are very thick, they are too strong for the paper which fastens them to the works, and will sometimes fly off without leading the fire. The formers for these leaders are made from 2 to 6-16ths of an inch diameter; but 4-16ths is the size generally made use of. The formers are made of smooth brass wire: when you use them, rub them over with grease, or keep them wet with paste, to prevent their sticking to the paper, which must be pasted all over. In rolling of pipes, make use of a rolling-board, but use it lightly: having rolled a pipe, draw out the former with one hand, holding the pipe as light as possible with the other; for if it press against the former, it will stick and tear the paper.

N. B. Make your leaders of different lengths, or in clothing of works you will cut a great many to waste. Leaders for marron batteries must be made of strong cartridge paper.

77. *Crackers.*

Cut some cartridge paper into pieces $3\frac{1}{2}$ inches broad, and one foot long; one edge of each fold down lengthwise about $\frac{3}{4}$ of an inch broad; then fold the double edge down $\frac{1}{4}$ of an inch, and turn the single edge back half over the double fold; then open it, and lay all along the channel, which is formed by the folding of the paper, some meal-powder; then fold it over and over till all the paper is doubled up, rubbing it down every turn; this done, bend it backwards and forwards, $2\frac{1}{2}$ inches, or thereabouts, at a time, as oft as the paper will allow; then hold all these folds flat and close, and with a small pinching cord give one turn round the middle of the cracker, and pinch it close; then bind it with a packthread as tight as you can; then, in the place where it was pinched, prime one end of it, and cap it with touch-paper. When these crackers are fired, they will give a report at every turn of the paper: if you would have a great number of bounces, you must cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you must have a piece of wood with a groove in it, deep enough to let in half the cracker; this will hold it straight while it is pinching. Fig. 12. represents a cracker complete.

78. *Single Reports.*

Cases for reports are generally rolled on one and two oz. formers, and seldom made larger but on particular occasions; they are made from two to four inches long, and very thick of paper. Having rolled a case, pinch one end quite close, and drive it down: then fill the case with corn-powder, only leaving room to pinch it at top; but before you pinch it, put in a piece of paper at top of the powder. Reports are fired by a vent, bored in the middle, or at one end, just as required.

79. *Marrons.*

Formers for marrons are from $\frac{3}{4}$ of an inch to $1\frac{1}{2}$ diameter. Cut the paper for the cases twice the diameter of the former broad, and long enough to go three times round: when you have rolled a case, paste down the edge and tie one end close; then with the former drive it down to take away the wrinkles, and make it flat at bottom; then fill the case with corn-powder one diameter and $\frac{1}{4}$ high, and fold down the rest of the case tight on the powder. The marron being thus made, wax some strong pack-thread with shoemakers wax; this thread wind up in a ball, then unwind two or three yards of it, and that part which is near the ball make fast to a hook; then take a marron, and stand as far from the hook as the pack-thread will reach, and wind it lengthwise round the marron as close as you can, till it will hold no more that way; then turn it, and wind the packthread on the short way, then lengthwise again, and so on till the paper is all covered; then make fast the end of the packthread, and beat down both ends of the marron to bring it in shape. The method of firing marrons is by making a hole at one end with an awl, and putting in a piece of quick-match; then take a piece of strong paper, in which wrap up the marron with two leaders, which must be put down to the vent, and the paper tied tight round them with small twine: these leaders are bent on each side, and their loose ends tied to other marrons, and are nailed in the middle to the rail of the stand, as in fig. 13. The use of winding the packthread in a ball is, that you may let it out as you want it, according to the quantity the marron may require; and that it may not be tied in knots, which would spoil the marron.

80. *Marron Batteries,*

If well managed, will keep time to a march, or a slow piece of music. Marron batteries are made of several stands, with a number of cross rails for the marrons; which are regulated by leaders, by cutting them of different lengths, and nailing them tight, or loose, according to the time of the music. In marron batteries you must use the large and small marrons, and the nails for the pipes must have flat heads.

81. *Line Rockets.*

Are made and drove as the sky-rockets, but have no heads, and the cases must be cut close to the clay: they are sometimes made with six or seven changes, but in general not more than four or five. The method of managing those rockets is thus: First, have a piece of light wood, the length of one of the rockets, turned round

round about $2\frac{1}{2}$ inches diameter, with a hole through the middle lengthwife, large enough for the line to go eafily through: if you defign four changes, have four grooves cut in the fwivel, one oppofite the other, to lay the rockets in.

The mouths of the rockets being rubbed with wet meal-powder, lay them in the grooves head to tail, and tie them faft; from the tail of the firft rocket carry a leader to the mouth of the fecond, and from the fecond to the third, and fo on to as many as there are on the fwivel, making every leader very fecure; but in fixing thefe pipes, take care that the quick-match does not enter the bores of the rockets: the rockets being fixed on the fwivel and ready to be fired, have a line 100 yards long, ftretched and fixed up tight, at any height from the ground; but be fure to place it horizontally: this length of line will do for $\frac{1}{2}$lb. rockets; but if larger, the line muft be longer. Before you put up the line, put one end of it through the fwivel; and when you fire the line rocket, let the mouth of that rocket which you fire firft face that end of the line where you ftand; then the firft rocket will carry the reft to the other end of the line, and the fecond will bring them back; and fo they will run out and in according to the number of rockets: at each end of the line there muft be a piece of flat wood for the rocket to ftrike againft, or its force will cut the line. Let the line be well foaped, and the hole in the fwivel very fmooth.

82. *Different Decorations for Line Rockets.*

To line rockets may be fixed great variety of figures, fuch as flying dragons, Mercuries, fhips, &c. Or they may be made to run on the line like a wheel; which is done in this manner. Have a flat fwivel made very exact, and on it tie two rockets obliquely, one on each fide, which will make it turn round all the way it goes, and form a circle of fire; the charge for thefe rockets fhould be a little weaker than common. If you would fhow two dragons fighting, get two fwivels made fquare, and on each tie three rockets together on the under fide; then have two flying dragons made of tin, and fix one of them on the top of each fwivel, fo as to ftand upright; in the mouth of each dragon put a fmall cafe of common fire, and another at the end of the tail; you may put two or three port-fires, of a ftrong charge, on one fide of their bodies, to fhow them. This done, put them on the line, one at each end; but let there be a fwivel in the middle of the line to keep the dragons from ftriking together: before you fire the rockets, light the cafes on the dragons; and if care be taken in firing both at the fame time, they will meet in the middle of the line, and feem to fight. Then they will run back and return with great violence; which will have a very pleafing effect. The line for thefe rockets muft be very long, or they will ftrike too hard together.

83. *Chinefe Flyers.*

Cafes for flyers may be made of different fizes, from one to eight ounces: they muft be made thick of paper, and eight interior diameters long; they are rolled in the fame manner as tourbillons, with a ftraight pafted edge, and pinched clofe at one end. The method of filling them is, the cafe being put in a mould, whofe cylinder, or foot, muft be flat at top without a nipple, fill it within $\frac{1}{2}$ a diameter of the middle; then ram in $\frac{1}{2}$ a diameter of clay, on that as much compofition as before, on which drive $\frac{1}{2}$ a diameter of clay; then pinch the cafe clofe, and drive it down flat: after this is done, bore a hole exactly through the centre of the clay in the middle; then in the oppofite fides, at both ends, make a vent; and in that fide you intend to fire firft make a fmall hole to the compofition near the clay in the middle, from which carry a quick-match, covered with a fingle paper, to the vent at the other end; then, when the charge is burnt on one fide, it will, by means of the quick-match, communicate to the charge on the other (which may be of a different fort). The flyers being thus made, put an iron pin, that muft be fixed in the work on which they are to be fired, and on which they are to run, through the hole in the middle; on the end of this pin muft be a nut to keep the flyer from running off. If you would have them turn back again after they are burnt, make both the vents at the ends on the fame fide, which will alter its courfe the contrary way.

84. *Table Rockets,*

Are defigned merely to fhow the truth of driving, and the judgment of a fire-worker, they having no other effect, when fired, than fpinning round in the fame place where they begin, till they are burnt out, and fhowing nothing more than an horizontal circle of fire.

The method of making thefe rockets is—Have a cone turned out of hard wood $2\frac{1}{2}$ inches diameter, and as much high; round the bafe of it draw a line; on this line fix four fpokes, two inches long each, fo as to ftand one oppofite the other; then fill four nine-inch one lb cafes with any ftrong compofition, within two inches of the top: thefe cafes are made like tourbillons, and muft be rammed with the greateft exactnefs.

Your rockets being filled, fix their open ends on the fhort fpokes; then in the fide of each cafe bore a hole near the clay; all thefe holes, or vents, muft be fo made that the fire of each cafe may act the fame way; from thefe vents carry leaders to the top of the cone, and tie them together. When you would fire the rockets, fet them on a fmooth table, and light the leaders in the middle, and all the cafes will fire together (fee fig. 14.) and fpin on the point of the cone. Plate CCCCXXIX.

Thefe rockets may be made to rife like tourbillons, by making the cafes fhorter, and boring four holes in the under fide of each at equal diftances: this being done, they are called *double tourbillons.*

Note, All the vents in the under fide of the cafes muft be lighted at once; and the fharp point of the cone cut off, at which place make it fpherical.

Sect. V. *Of Wheels and other Works.*

85. *Single Vertical Wheels.*

There are different forts of vertical wheels; fome having their fells of a circular form, others of an hexagon, octagon, or decagon form, or any number of fides, according to the length of the cafes you defign for the wheel: your fpokes being fixed in the nave, nail flips of tin, with their edges turned up, fo as to form grooves for the cafes to lie in, from the end of one fpoke to another; then tie your cafes in the grooves head to tail, in the fame manner as thofe on the horizontal waterwheel, fo that the cafes fucceffively taking fire from one another, will keep the wheel in an equal rotation. Two of thefe wheels are very oft fired together, one on each fide

Of Wheels, &c.

side of a building; and both lighted at the same time, and all the cases filled alike, to make them keep time together; which they will do if made by the following directions. In all the cases of both wheels, except the first, on each wheel drive two or three ladles full of slow fire, in any part of the cases; but be careful to ram the same quantity in each case, and in the end of one of the cases, on each wheel, you may ram one ladlefull of dead-fire composition, which must be very lightly drove; you may also make many changes of fire by this method.

Let the hole in the nave of the wheel be lined with brass, and made to turn on a smooth iron spindle. On the end of this spindle let there be a nut, to screw off and on; when you have put the wheel on the spindle, screw on the nut, which will keep the wheel from flying off. Let the mouth of the first case be a little raised. See fig. 15. Vertical wheels are made from 10 inches to 3 feet diameter, and the size of the cases must differ accordingly; 4-oz. cases will do for wheels of 14 or 16 inches diameter, which is the proportion generally used. The best wood for wheels of all sorts is a light and dry beech.

86. *Horizontal Wheels*,

Are best when their fells are made circular; in the middle of the top of the nave must be a pintle, turned out of the same piece as the nave, two inches long, and equal in diameter to the bore of one of the cases of the wheel: there must be a hole bored up the centre of the nave, within half an inch of the top of the pintle. The wheel being made, nail at the end of each spoke (of which there should be six or eight) a piece of wood, with a groove cut in it to receive the case. Fix these pieces in such a manner that half the cases may incline upwards and half downwards, and that, when they are tied on, their heads and tails may come very near together; from the tail of one case to the mouth of the other carry a leader, which secure with pasted paper. Besides these pipes, it will be necessary to put a little meal-powder inside the pasted paper, to blow off the pipe, that there may be no obstruction to the fire from the cases. By means of these pipes the case will successively take fire, burning one upwards and the other downwards. On the pintle fix a case of the same sort as those on the wheel; this case must be fired by a leader from the mouth of the last case on the wheel, which case must play downwards: instead of a common case in the middle, you may put a case of Chinese fire, long enough to burn as long as two or three of the cases on the wheel.

Horizontal wheels are oft fired two at a time, and made to keep time like vertical wheels, only they are made without any slow or dead fire; 10 or 12 inches will be enough for the diameter of wheels with six spokes. Fig. 16. represents a wheel on fire, with the first case burning.

87. *Spiral Wheels*,

Are only double horizontal wheels, and made thus: The nave must be about 6 inches long, and somewhat thicker than the single sort; instead of the pintle at top, make a hole for the case to be fixed in, and two sets of spokes, one set near the top of the nave, and the other near the bottom. At the end of each spoke cut a groove wherein you tie the cases, there being no fell; the spokes should not be more than $3\frac{1}{2}$ inches long from the nave, so that the wheel may not be more than 8 or 9 inches diameter; the cases are placed in such a manner, that those at top play down, and those at bottom play up, but let the third or fourth case play horizontally. The case in the middle may begin with any of the others you please: 6 spokes will be enough for each set, so that the wheel may consist of 12 cases, besides that on the top: the cases 6 inches each.

88. *Plural Wheels*,

Are made to turn horizontally, and to consist of three sets of spokes, placed 6 at top, 6 at bottom, and 4 in the middle, which must be a little shorter than the rest: let the diameter of the wheel be 10 inches; the cases must be tied on the ends of the spokes in grooves cut on purpose, or in pieces of wood nailed on the ends of the spokes, with grooves cut in them as usual: in clothing these wheels, make the upper set of cases play obliquely downwards, the bottom set obliquely upwards, and the middle set horizontally. In placing the leaders, you must order it so that the cases may burn thus, viz. first up, then down, then horizontal, and so on with the rest. But another change may be made, by driving in the end of the 8th case two or three ladlefuls of slow fire, to burn till the wheel has stopped its course; then let the other cases be fixed the contrary way, which will make the wheel run back again: for the case at top you may put a small gerbe; and let the cases on the spokes be short, and filled with a strong brilliant charge.

89. *Illuminated Spiral Wheel*.

First have a circular horizontal wheel made two feet diameter, with a hole quite through the nave; then take three thin pieces of deal, three feet long each, and $\frac{1}{4}$ of an inch broad each; one end of each of these pieces nail to the fell of the wheel, at an equal distance from one another, and the other end nail to a block with a hole in its bottom, which must be perpendicular with that in the block of the wheel, but not so large. The wheel being thus made, have a hoop planed down very thin and flat; then nail one end of it to the fell of the wheel, and wind it round the three sticks in a spiral line from the wheel to the block at top: on the top of this block fix a case of Chinese fire; on the wheel you may place any number of cases, which must incline downwards, and burn two at a time. If the wheel should consist of 10 cases, you may let the illuminations and Chinese fire begin with the second cases. The spindle for this wheel must be a little longer than the cone, and made very smooth at top, on which the upper block is to turn, and the whole weight of the wheel to rest. See fig. 17.

90. *Double Spiral Wheel*.

For this wheel the block, or nave, must be as long as the height of the worms, or spiral lines, but must be made very thin, and as light as possible. In this block must be fixed several spokes, which must diminish in length, from the wheel to the top, so as not to exceed the surface of a cone of the same height. To the ends of these spokes nail the worms, which must cross each other several times: these worms clothe with illuminations, the same as those on the single wheels; but the horizontal wheel you may clothe as you like. At top of the worm place a case of spur-fire, or an amber light. See fig. 18. This figure is shown without leaders, to prevent a confusion of lines.

91. *Balloon Wheels*,

Are made to turn horizontally: they must be made 2 feet

Wheels, &c. 2 feet diameter, without any ſpokes; and very ſtrong, with any number of ſides. On the top of a wheel range and fix in pots, 3 inches diameter and 7 inches high each, as many of theſe as there are caſes on the wheel: near the bottom of each pot make a ſmall vent; into each of theſe vents carry a leader from the tail of each caſe; ſome of the pots load with ſtars, and ſome with ſerpents, crackers, &c. As the wheels turn, the pots will ſucceſſively be fired, and throw into the air a great variety of fires.

92. *Fruiloni Wheels.*

Firſt have a nave made 9 inches long and 3 in diameter: near the bottom of this nave fix 8 ſpokes, with a hole in the end of each, large enough to receive a 2 or 4 ounce caſe: each of theſe ſpokes may be 14 inches long from the block. Near the top of this block fix 8 more of the ſame ſpokes, exactly over the others, but not ſo long by 2 inches. As this wheel is to run horizontally, all the caſes in the ſpokes muſt play obliquely upwards, and all thoſe in the ſpokes at bottom obliquely downwards. This being done, have a ſmall horizontal wheel made with 8 ſpokes, each 5 inches long from the block: on the top of this wheel place a caſe of brilliant fire: all the caſes on this wheel muſt play in an oblique direction downwards, and burn 2 at a time, and thoſe on the large wheel 4 at a time; that is, 2 of thoſe in the top ſet of ſpokes, and 2 of thoſe in the bottom ſet of ſpokes.

The 4 firſt caſes on the large wheel, and the 2 firſt on the ſmall, muſt be fired at the ſame time, and the brilliant fire at top at the beginning of the laſt caſes. The caſes of the wheels may be filled with a grey charge. When theſe wheels are completed, you muſt have a ſtrong iron ſpindle, made 4 feet 6 inches long, and fixed perpendicularly on the top of a ſtand: on this put the large wheel, whoſe nave muſt have a hole quite through from the bottom to the top. This hole muſt be large enough to turn eaſy round the bottom of the ſpindle, at which place there muſt be a ſhoulder, to keep the wheel from touching the ſtand: at the top of the ſpindle put the ſmall wheel, and join it to a large one with a leader, in order that they may be fired both together.

93. *Caſcades of Fire,*

Are made of any ſize; but one made according to the dimenſions of that ſhown in fig. 1. will be large enough for 8-oz. caſes. Let the diſtance from A to B be 3 feet; from B to C 2 feet 6 inches; and from CD 2 feet; and let the croſs piece at A be 4 feet long: then from each end of this piece draw a line to D; then make the other croſs pieces ſo long as to come within thoſe lines. The top piece D may be of any length, ſo as to hold the caſes, at a little diſtance from each other; all the croſs pieces are fixed horizontally, and ſupported by brackets; the bottom croſs piece ſhould be about 1 foot 6 inches broad in the middle, the ſecond 1 foot, the third 9 inches, and the top piece 4 inches: the caſes may be made of any length, but muſt be filled with a brilliant charge. On the edges of the croſs pieces muſt be nailed bits of wood, with a groove cut in each piece, large enough for a caſe to lie in. Theſe bits of wood are fixed ſo as to incline downwards, and that the fire from one tier of caſes may play over the other. All the caſes being tied faſt on, carry leaders from one to the other; and let there be a pipe hung from the mouth of one of the caſes, covered at the end with a ſingle paper, which you burn to fire the caſcade.

Plate CCXXX.

Of Wheels, &c.

94. *The Fire-Tree.*

To make a fire-tree, as ſhewn by fig. 2. you muſt firſt have a piece of wood 6 feet long, and 3 inches ſquare; then at E, 9 inches from the top, make a hole in the front, and in each ſide; or, inſtead of holes, you may fix ſhort pegs, to fit the inſide of the caſes. At F, 9 inches from E, fix 3 more pegs; at G, 1 foot 9 inches from F, fix 3 pegs; at H, 9 inches from G, fix 3 pegs; at I, 9 inches from H, fix 3 pegs, inclining downwards; but all the other pegs muſt incline upwards, that the caſes may have the ſame inclination as you ſee in the figure: then at top place a 4-inch mortar, loaded with ſtars, rains, or crackers. In the middle of this mortar place a caſe filled with any ſort of charge, but let it be fired with the other caſes: a brilliant charge will do for all the caſes; but the mortar may be made of any diameter, and the tree of any ſize; and on it any number of caſes, provided they are placed in the manner deſcribed.

95. *Chineſe Fountains.*

To make a Chineſe fountain, you muſt have a perpendicular piece of wood 7 feet long and $2\frac{1}{2}$ inches ſquare. Sixteen inches from the top, fix on the front a croſs-piece 1 inch thick, and $2\frac{1}{2}$ broad, with the broad ſide up: below this, fix 3 more pieces of the ſame width and thickneſs, at 16 inches from each other: let the bottom rail be 5 feet long, and the others of ſuch a length as to allow the fire-pumps to ſtand in the middle of the intervals of each other. The pyramid being thus made, fix in the holes made in the bottom rail 5 fire-pumps, at equal diſtances; on the 2d rail, place 4 pumps; on the 3d, 3; on the 4th, 2; and on the top of the poſt, 1; but place them all to incline a little forwards, that, when they throw out the ſtars, they may not ſtrike againſt the croſs rails. Having fixed your fire-pumps, clothe them with leaders, ſo that they may all be fired together. See fig. 3.

96. *Of illuminated Globes with horizontal Wheels.*

The hoops for theſe globes may be made of wood, tin, or iron wire, about 2 feet diameter. For a ſingle globe take two hoops, and tie them together, one within the other, at right angles; then have a horizontal wheel made, whoſe diameter muſt be a little wider than the globe, and its nave 6 inches long; on the top of which the globe is fixed, ſo as to ſtand 3 or 4 inches from the wheel: on this wheel you may put any number of caſes, filled with what charge you like; but let two of them burn at a time: they may be placed horizontally, or to incline downwards, juſt as you chooſe. Now, when the wheel is clothed, fix on the hoops as many illuminations as will ſtand within $2\frac{1}{2}$ inches of each other: theſe you faſten on the hoops with ſmall iron binding wire; and when they are all on, put on your pipes of communication, which muſt be ſo managed as to light them all with the 2d or 3d caſe on the wheel. The ſpindle on which the globe is to run muſt go through the block of the wheel, up to the inſide of the top of the globe; where muſt be fixed a bit of braſs, or iron, with a hole in it to receive the point of the ſpindle, on which the whole weight of the wheel is to bear, as in fig. 4. which repreſents a globe on its ſpindle. By this method may be made a

crown,

Of Wheels, &c.

crown, which is done by having the hoops bent in the form of a crown. Sometimes globes and crowns are ordered so as to stand still, and the wheel only to turn round; but when you would have the globe or crown to stand still, and the wheel to run by itself, the block of the wheel must not be so long, nor the spindle any longer than to just raise the globe a little above the wheel; and the wheel cases and illumination must begin together.

97. *Dodecaedron,*

So called because it nearly represents a twelve-sided figure, is made thus. First have a ball turned out of some hard wood, 14 inches diameter: when done, divide its surface into 14 equal parts, from which bore holes $1\frac{1}{4}$ inch diameter, perpendicular to the centre, so that they may all meet in the middle: then let there be turned in the inside of each hole a female screw; and to all the holes but one, must be made a round spoke 5 feet long, with 4 inches of the screw at one end to fit the holes; then in the screw-end of all the spokes bore a hole, 5 inches up, which must be bored flanting, so as to come out at one side, a little above the screw; from which cut a small groove along the spoke, within 6 inches of the other end, where you make another hole through to the other side of the spoke. In this end fix a spindle, on which put a small wheel of 3 or 4 sides, each side 6 or 7 inches long: these sides must have grooves cut in them, large enough to receive a 2 or 4 oz. case. When these wheels are clothed, put them on the spindles, and at the end of each spindle put a nut to keep the wheel from falling off. The wheels being thus fixed, carry a pipe from the mouth of the first case on each wheel, through the hole in the side of the spoke, and from thence along the groove, and through the other hole, so as to hang out at the screw-end about an inch. The spokes being all prepared in this manner, you must have a post, on which you intend to fire the work, with an iron screw in the top of it, to fit one of the holes in the ball: on the screw fix the ball; then in the top hole of the ball put a little meal-powder, and some loose quick-match: then screw in all the spokes; and in one side of the ball bore a hole, in which put a leader, and secure it at the end; and your work will be ready to be fired. By this leader the powder and match in the centre is fired, which will light the match at the ends of the spokes all at once, whereby all the wheels will be lighted at once. There may be an addition to this piece, by fixing a small globe on each wheel, or one on the top wheel only. A grey charge will be proper for the wheel-cases.

98. *The Yew-Tree of brilliant Fire,*

Is represented by fig. 5. as it appears when burning. First, let A be an upright piece of wood, 4 feet long, 2 inches broad, and 1 thick: at top of this piece, on the flat side, fix a hoop 14 inches diameter; and round its edge and front place illuminations, and in the centre a 5-pointed star; then at E, which is $1\frac{1}{2}$ foot from the edge of the hoop, place 2 cases of brilliant fire, one on each side: these cases should be 1 foot long each: below these fix 2 more cases of the same size, and at such a distance, that their mouths may almost meet them at top: then close to the ends of these cases fix 2 more of the same cases; they must stand parallel to them at E. The cases being thus fixed, clothe them with leaders; so that they, with the illuminations and stars at top, may all take fire together.

99. *Stars with Points for regulated Pieces, &c.*

These stars are made of different sizes, according to the work for which they are intended: they are made with cases from 1 oz. to 1 lb. but in general with 4 oz. cases, 4 or 5 inches long: the cases must be rolled with paste, and twice as thick of paper as a rocket of the same bore. Having rolled a case, pinch one end of it quite close: then drive in $\frac{1}{2}$ a diameter of clay; and when the case is dry, fill it with composition, 2 or 3 inches to the length of the cases with which it is to burn: at top of the charge drive some clay; as the ends of these cases are seldom pinched, they would be liable to take fire. Having filled a case, divide the circumference of it at the pinched end close to the clay into 5 equal parts; then bore 5 holes with a gimblet, about the size of the neck of a common 4-oz. case, into the composition: from one hole to the other carry a quick-match, and secure it with paper: this paper must be put on in the manner of that on the ends of wheel-cases, so that the hollow part, which projects from the end of the case, may serve to receive a leader from any other work, to give fire to the points of the stars. These stars may be made with any number of points.

100. *Fixed Sun with a transparent Face.*

To make a sun of the best sort, there should be two rows of cases, as in fig. 6. which will show a double glory, and make the rays strong and full. The frame, or sun-wheel, must be made thus: Have a circular flat nave made very strong, 12 inches diameter: to this fix 6 strong flat spokes, A,B,C,D,E,F. On the front of these fix a circular fell, 5 feet diameter; within which fix another fell, the length of one of the sun-cases less in diameter; within this fix a 3d fell, whose diameter must be less than the 2d by the length of 1 case and 1-3d. The wheel being made, divide the fells into so many equal parts as you would have cases (which may be done from 24 to 44): at each division fix a flat iron staple; these staples must be made to fit the cases, to hold them fast on the wheel; let the staples be so placed, that one row of cases may lie in the middle of the intervals of the other.

In the centre of the block of the sun drive a spindle, on which put a small hexagon wheel, whose cases must be filled with the same charge as the cases of the sun: two cases of this wheel must burn at a time, and begin with them on the fells. Having fixed on all the cases, carry pipes of communication from one to the other, as you see in the figure, and from one side of the sun to the wheel in the middle, and from thence to the other side of the sun. These leaders will hold the wheel steady while the sun is fixing up, and will also be a sure method of lighting both cases of the wheel together. A sun thus made is called a *brilliant sun*, because the wood work is entirely covered with fire from the wheel in the middle, so that there appears nothing but sparks of brilliant fire: but if you would have a transparent face in the centre, you must have one made of pasteboard of any size. The method of making a face is, by cutting out the eyes, nose, and mouth, for the sparks of the wheel to appear through; but instead of this face, you may have one painted on oiled paper, or Persian silk, strained tight on a hoop; which

which hoop must be supported by 3 or 4 pieces of wire at 6 inches distance from the wheel in the centre, so that the light of it may illuminate the face. By this method you may have, in the front of a sun, VIVAT REX, cut in pasteboard, or Apollo painted on silk; but, for a small collection, a sun with a single glory, and a wheel in front, will be most suitable. Half-pound cases, filled 10 inches with composition, will be a good size for a sun of 5 feet diameter; but, if larger, the cases must be greater in proportion.

101. *Three Vertical Wheels illuminated, which turn on their own Naves upon a horizontal Table.*

A plan of this is shown by fig. 7. Let D be a deal table 3 feet in diameter: this table must be fixed horizontally on the top of a post; on this post must be a perpendicular iron spindle, which must come through the centre of the table: then let A,B,C, be 3 spokes joined to a triangular flat piece of wood, in the middle of which make a hole to fit easily over the spindle: let E,F,G, be pieces of wood, 4 or 5 inches long each, and 2 inches square, fixed on the under sides of the spokes; in these pieces make holes lengthwise to receive the thin part of the blocks of the wheels, which, when in, are prevented from coming out by a small iron pin being run through the end of each. K, L, M, are 3 vertical octagon wheels, 18 inches diameter each: the blocks of these wheels must be long enough for 3 or 4 inches to rest on the table; round which part drive a number of sharp points of wire, which must not project out of the blocks more than 1-16th of an inch: the use of these points is, that, when the blocks run round, they will stick in the table, and help the wheels forward: if the naves are made of strong wood, one inch will be enough for the diameter of the thin part, which should be made to turn easy in the holes in the pieces E, F, G. On the front of the wheels make 4 or 5 circles of strong wire, or flat hoops, and tie on them as many illuminations as they will hold at 2 inches from each other: instead of circles, you may make spiral lines, clothed with illuminations, at the same distance from each other as those on the hoops. When illuminations are fixed on a spiral line in the front of a wheel, they must be placed a little on the slant, the contrary way that the wheel runs: the cases for these wheels may be filled with any coloured charge, but must burn only one at a time.

The wheels being thus prepared, you must have a globe, crown, or spiral wheel, to put on the spindle in the middle of the table: this spindle should be just long enough to raise the wheel of the globe, crown, or spiral wheel, so high that its fire may play over the 3 vertical wheels: by this means their fires will not be confused, nor will the wheels receive any damage from the fire of each other. In clothing this work, let the leaders be so managed, that all the wheels may light together, and the illuminations after 2 cases of each wheel are burned.

102. *Illuminated Chandelier.*

Illuminated works are much admired by the Italians, and indeed are a great addition to a collection of works: in a grand exhibition an illuminated piece should be fired after every two or three wheels, or fixed pieces of common and brilliant fires; and likewise illuminated works may be made cheap, quick, and easy.

To make an illuminated chandelier, you must first have one made of thin wood, (see fig. 8.) The chandelier being made, bore in the front of the branches, and in the body, and also in the crown at top, as many holes for illuminations as they will contain at 3 inches distance from each other: in these holes put illuminations filled with white, blue, or brilliant charge. Having fixed in the port-fires, clothe them with leaders, so that the chandelier and crown may light together. The small circles on this figure represent the mouths of the illuminations, which must project straight from the front.

103. *Illuminated Yew Tree.*

First have a tree made of wood, such as is shown by fig. 9. The middle piece or stem, on which the branches are fixed, must be 8 feet 6 inches high: at the bottom of this piece draw a line, at right angles, 2 feet 6 inches long at each side; then from L, which is 1 foot 6 inches from the bottom, draw a line on each side to C and D: these lines will give the length of the two first branches. Then put on the two top branches parallel to them at bottom: let the length of each of these branches be 1 foot from the stem: from the ends of these two branches draw a line to C and D: then fix on 5 more branches at an equal distance from each other, and their length will be determined by the lines AC and ED. When the branches are fixed, place illuminating portfires on the top of each, as many as you choose: behind the top of the stem fasten a gerbe or white fountain, which must be fired at the beginning of the illuminations on the tree.

104. *Flaming Stars with brilliant Wheels.*

To make a flaming star, you must first have made a circular piece of strong wood about 1 inch thick and 2 feet diameter: round this block fix 8 points, 2 feet 6 inches long each; 4 of these points must be straight and 4 flaming: these points being joined on very strong, and even with the surface of the block, nail tin or pasteboard on their edges, from the block to the end of each, where they must be joined: this tin must project in front 8 inches, and be joined where they meet at the block; round the front of the block fix 4 pieces of thick iron wire, 8 inches long each, equally distant from each other: this being done, cut a piece of pasteboard round, 2 feet diameter, and draw on it a star, as may be seen in fig. 10. Cut out this star, and on the back of it paste oiled paper; then paint each point half red and half yellow, lengthwise; but the body of the star must be left open, wherein must run a brilliant wheel, made thus: Have a light block turned 9 inches long: at each end of it fix 6 spokes; at the end of each spoke put a 2 ounce case of brilliant fire: the length of these cases must be in proportion to the wheel, and the diameter of the wheel when the cases are on must be a little less than the diameter of the body of the small star: the cases on the spokes in front must have their mouths incline outwards, and those on the inside spokes must be placed so as to form a vertical circle of fire. When you place your leaders, carry the first pipe from the tail of 1 of the cases in front to the mouth of 1 of the inside cases, and from the tail of that to another in front, and so on to all the cases. Your wheel being made, put it on a spindle, in the centre of the star; this spindle must have a shoulder at bottom, to keep the wheel at a little distance from the block. This wheel must be kept on the

Of Wheels, &c. the spindle by a nut at the end; having fixed on the wheel, fasten the transparent star to the 4 pieces of wire: when you fire it, you will only see a common horizontal wheel; but when the first case is burnt out, it will fire one of the vertical cases, which will show the transparent star, and fill the large flames and points with fire; then it will again appear like a common wheel, and so on for 12 changes.

105. *Projected regulated Piece of nine Mutations.*

A regulated piece, if well executed, is as curious as any in fire-works: it consists of fixed and moveable pieces on one spindle, representing various figures, which take fire successively one from another, without any assistance after lighting the first mutation. See fig. 11.

I. Names of the mutations, with the colour of fire and size of the case belonging to each.

First mutation is a hexagon vertical wheel, illuminated in front with small portfires tied on the spokes; this wheel must be clothed with 2 ounce cases, filled with black charge; the length of these cases is determined by the size of the wheel, but must burn singly.

Second mutation is a fixed piece, called a *golden glory*, by reason of the cases being filled with spur-fire. The cases must stand perpendicular to the block on which they are fixed, so that, when burning, they may represent a glory of fire. This mutation is generally composed of 5 or 7 two ounce cases.

Third mutation is moveable; and is only an octagon vertical wheel, clothed with 4 ounce cases, filled with brilliant charge: 2 of these cases must burn at a time. In this wheel you may make changes of fire.

Fourth mutation, is a fixed sun of brilliant fire, consisting of 12 four ounce cases: the necks of these cases must be a little larger than those of 4 ounce wheel-cases. In this mutation may be made a change of fire, by filling the cases half with brilliant charge, and half with grey.

Fifth mutation, is a fixed piece, called the *porcupine's quills*. This piece consists of 12 spokes, standing perpendicular to the block in which they are fixed; on each of these spokes, near the end, must be placed a 4 ounce case of brilliant fire. All these cases must incline either to the right or left, so that they may all play one way.

Sixth mutation, is a standing piece, called the *cross fire*. This mutation consists of 8 spokes fixed in a block; near the end of each of those spokes must be tied two 4 ounce cases of white charge, one across the other, so that the fires from the cases on one spoke may intersect the fire from the cases on the other.

Seventh mutation, is a fixed wheel, with 2 circular fells, on which are placed 16 eight-ounce cases of brilliant fire, in the form of a star. This piece is called a *fixed star of wild-fire*.

Eighth mutation. This is a beautiful piece, called a *brilliant star-piece*. It consists of 6 spokes, which are strengthened by 2 fells of a hexagon form, at some distance from each other: at the end of each spoke, in the front, is fixed a brilliant star of 5 points; and on each side of every star is placed a 4 ounce case of black or grey charge; these cases must be placed with their mouths sidewise, so that their fires may cross each other.

Ninth mutation, is a wheel-piece. This is composed of 6 long spokes, with a hexagon vertical wheel at the end of each; these wheels run on spindles in the front of the spokes; all the wheels are lighted together: 2 ounce cases will do for these wheels, and may be filled with any coloured charge.

II. Proportions of the mutations, with the method of conveying the fire from one to the other, and the distance they stand one from the other on the spindle.

First Mutation, must be a hexagon vertical wheel, 14 inches diameter; on one side of the block, whose diameter is $2\frac{1}{4}$ inches, is fixed a tin barrel A (see fig. 11. n° 1.) This barrel must be a little less in diameter than the nave; let the length of the barrel and block be 6 inches. Having fixed the cases on the wheel, carry a leader from the tail of the last case into the tin barrel through a hole made on purpose, 2 inches from the block; at the end of this leader let there be about 1 inch or 2 of loose match; but take care to secure well the hole wherein the pipe is put, to prevent any sparks falling in, which would light the second mutation before its time, and confuse the whole.

Second mutation is thus made. Have a nave turned $2\frac{1}{2}$ inches diameter, and 3 long; then let $\frac{1}{2}$ an inch of that end which faces the first wheel be turned so as to fit easy into the tin barrel of the first mutation, which must turn round it without touching. On the other end of the block fix a tin barrel B, n° 2. This barrel must be 6 inches long, and only half an inch of it to fit on the block. Round the nave fix 5 spokes, $1\frac{1}{2}$ inch long each; the diameter of the spokes must be equal to a 2 oz. former. On these spokes put five 7-inch 2-oz. cases of spur-fire, and carry leaders from the mouth of one to the other, that they may all light together. Then from the mouth of one of the cases carry a leader through a hole bored slantwise in the nave, from between the spokes, to the front of the block near the spindle hole: the end of this leader must project out of the hole into the barrel of the first mutation, so that when the pipe which comes from the end of the last case on the first wheel flashes, it may take fire, and light the 2d mutation. To communicate the fire to the 3d mutation, bore a hole near the bottom of one of the 5 cases to the composition, and from thence carry a leader into a hole made in the middle of the barrel B: this hole must be covered with pasted paper.

Third mutation, may be either an octagon or hexagon wheel, 20 inches diameter; let the nave be $3\frac{1}{2}$ inches diameter, and $3\frac{1}{2}$ in length; $1\frac{1}{2}$ inch of the front of the nave must be made to fit in the barrel B. On the other end of the block fix a tin barrel C, n° 3. This barrel must be $6\frac{1}{2}$ inches in length, one inch of which must fit over the block. The cases of this wheel must burn 2 at a time; and from the mouths of the 2 first cases carry a leader, through holes in the nave, into the barrel of the second mutation, after the usual manner: but besides these leaders let a pipe go across the wheel from one first case to the other; then from the tail of one of the last cases carry a pipe into a hole in the middle of the barrel C: at the end of this pipe let there be some loose quick-match.

Fourth and fifth mutations. These may be described under

Wheels &c. under one head, as their naves are made of one piece, which from E to F is 14 inches; E, a block 4 inches diameter, with 10 or 12 short spokes, on which are fixed 11-inch 8-oz. cases: let the front of this block be made to fit easy in the barrel C, and clothe the cases so that they may all light together; and let a pipe be carried through a hole in the block into the barrel C, in order to receive the fire from the leader brought from the last case on the wheel. G is the nave of the 5th mutation, whose diameter must be $4\frac{1}{2}$ inches; in this nave fix 10 or 12 spokes, $1\frac{1}{2}$ foot in length each; these spokes must stand 7 inches distant from the spokes of the 4th mutation; and at the end of each spoke tie a 4-oz. case, as n° 5. All these cases are to be lighted together, by a leader brought from the end of one of the cases on n° 4. Let F and H be of the same piece of wood as E and G, but as much thinner as possible, to make the work light.

Sixth and seventh mutations. The blocks of these 2 mutations are turned out of one piece of wood, whose length from F to P is 15 inches. L, a block 5 inches diameter, in which are fixed 8 spokes, each 2 feet 4 inches long; at the end of each spoke tie two 4-oz. cases, as n° 6. All these cases must be fired at the same time, by a pipe brought from the end of one of the cases on the 5th mutation. Let the distance between the spokes at L, and those in the 5th mutation, be 7 inches. M, the nave of the 7th mutation, whose diameter must be $5\frac{1}{2}$ inches: in this nave fix 8 spokes, and on the front of them 2 circular fells, one of 4 feet 8 inches diameter, and one of 3 feet 11 diameter; on these fells tie 16 8-oz. or pound cases, as in n° 7. and carry leaders from one to the other, so that they may be all fired together. This mutation must be fired by a leader brought from the tail of one of the cases on the 6th mutation.

Eighth and ninth mutations. The blocks of these may be turned out of one piece, whose length from P to D must be 12 inches. O, the block of the 8th mutation, which must be 6 inches diameter; and in it must be fixed 6 spokes, each 3 feet in length, strengthened by an hexagon fell within 3 or 4 inches of the ends of the spokes: close to the end of each spoke, in the front, fix a five-pointed brilliant star; then 7 inches below each star tie two 10-inch 8 oz. cases, so that the upper ends of the cases may rest on the fells, and their ends on the spokes. Each of these cases must be placed parallel to the opposite fell (see n° 8.) NNN, &c. are the cases, and kkk, &c. the stars.

The 9th mutation is thus made. Let D be a block 7 inches diameter. In this block must be screwed 6 spokes, 6 feet long each, with holes and grooves for leaders, as those in the dodecaedron; at the end of each spoke, in the front, fix a spindle for a hexagon vertical wheel, 10 inches diameter, as in n° 9. When these wheels are on, carry a leader from each into the block, so that they may all meet; then lead a pipe from the end of one of the cases of the 8th mutation, through a hole bored in the block D, to meet the leaders from the vertical wheels, so that they may all be fired together.

The spindles for larger pieces are required to be made very strong, and as exact as possible: for a piece of 9 mutations, let the spindle be at the large end 1 inch diameter, and continue that thickness as far as the 7th mutation; and thence to the 5th, let its diameter be $\frac{3}{4}$ of an inch; from the 5th to the 4th, 5-8ths of an inch; from the 4th to the 2d, $\frac{1}{2}$ inch; and from the 2d to the end, 3-8ths of an inch. At the small end must be a nut to keep on the first wheel, and at the thick end must be a large nut, as shown by the figure; so that the screw part of the spindle being put through a post, and a nut screwed on tight, the spindle will be held fast and steady: but you are to observe, that that part of the spindle on which the moveable pieces are to run, be made long enough for the wheels to run easy without sticking; the fixed pieces being made on different blocks, the leaders must be joined, after they are fixed on the spindle. The best method of preventing the fixed mutations from moving on the spindle, is to make that part of the spindle which goes through them square; but as it would be difficult to make square holes through such long blocks as are sometimes required, it will be best to make them thus: Bore a hole a little larger than the diameter of the spindle; and at each end of the block, over the hole, fasten a piece of brass with a square hole in it to fit the spindle.

Of Wheel, &c.

106. *To make an Horizontal Wheel change to a Vertical Wheel with a Sun in front.*

The sudden change of this piece is very pleasing; and gives great surprise to those who are not acquainted with the contrivance. A wheel for this purpose should be about three feet diameter, and its fell circular; on which tie 16 half-pound cases filled with brilliant charge: two of these cases must burn at a time; and on each end of the nave must be a tin barrel of the same construction as those on the regulated piece. The wheel being completed, prepare the post or stand thus: First have a stand made of any height, about three or four inches square; then saw off from the top a piece two feet long; this piece join again at the place where it was cut, with a hinge on one side, so that it may lift up and down in the front of the stand; then fix on the top of the bottom-part of the stand, on each side, a bracket; which brackets must project at right angles with the stand, one foot from the front, for the short piece to rest on. These brackets must be placed a little above the joint of the post, so that when the upper stand falls, it may lie between them at right angles with the bottom stand; which may be done by fixing a piece of wood, one foot long, between the brackets, and even with the top of the bottom stand; then, as the brackets rise above the bottom stand, they will form a channel for the short post to lie in, and keep it steady without straining the hinge. On the side of the short post, opposite the hinge, nail a piece of wood, of such a length, that, when the post is perpendicular, it may reach about $1\frac{1}{2}$ feet down the long post; to which being tied, it will hold the short stand upright. The stand being thus prepared, in the top of it fix a spindle 10 inches long: on this spindle put the wheel: then fix on a brilliant sun with a single glory; the diameter of this sun must be 6 inches less than that of the wheel. When you fire this piece, light the wheel first, and let it run horizontally till four cases are consumed: then from the end of the fourth case carry a leader into the tin barrel that turns over the end of the stand: this leader must be met by another brought through the top of the post, from a case filled with a strong

 port-

Of Wheels, &c.

port-fire charge, and tied to the bottom post, with its mouth facing the packthread which holds up the stand; so that when this case is lighted, it will burn the packthread, and let the wheel fall forward, by which means it will become vertical: then from the last case of the wheel, carry a leader into the barrel next the sun, which will begin as soon as the wheel is burnt out.

107. *Grand Volute illuminated with a projected Wheel in front.*

First have two hoops made of strong iron wire, one of 6 feet diameter, and one of 4 feet 2 inches; these hoops must be joined to scrolls A, A, A, &c. as in fig. 1. These scrolls must be made of the same sort of wire as the hoops; on these scrolls tie, with iron-binding wire, as many illuminating port-fires as they will hold, at two inches distance; clothe these port-fires with leaders, so that they may all take fire together.—Then let C be a circular wheel of four spokes, 3 feet 6 inches diameter; and on its fell tie as many 4-oz. cases, head to tail, as will complete the circle, only allowing a sufficient distance between the cases, that the fire may pass free; which may be done by cutting the upper part of the end of each case a little shelving: on each spoke fix a 4-oz. case, about three inches from the fell of the wheel: these cases are to burn one at a time, and the first of them to begin with those on the fell, of which four are to burn at a time; so that the wheel will last no longer than $\frac{1}{4}$ of the cases on the fell, which in number should be 16 or 20. On the front of the wheel form a spiral line with strong wire, on which tie port-fires, placing them on a slant, with their mouths to face the same way as the cases on the wheel: all these port-fires must be fired with the second cases of wheel. Let D, D, D, &c. be spokes of wood, all made to screw into a block in the centre; each of these spokes may be in length about 4 feet 6 inches; in the top of each fix a spindle, and on each spindle put a spiral wheel of 8 spokes, such as E, E, E, &c. The blocks of these wheels must have a hole at top for the centre cases, and the spindle must have nuts screwed on their ends; which nuts should fit in the holes at top of the blocks, so that all the wheels must be put on before you fix in the centre cases: as some of these wheels, by reason of their situation, will not bear on the nut, it will be necessary to have smooth shoulders made on the spindles for the blocks to run on. The cases of these wheels are to burn double; and the method of firing them, is by carrying a leader from each down the spokes into the block in the centre, as in the dodecaedron, but the centre case of each wheel must begin with the two last cases as usual. It is to be observed, that the large circular wheel in front must have a tin barrel on its block, into which a pipe must be carried from one of the second cases on the wheel; this pipe being met by another from the large block, in which the 8 spokes are screwed, will fire all the spiral wheels and the illuminating port-fires at the same time. The cases of the projected wheel may be filled with a white charge, and those of the spiral wheels with a grey.

Plate dcccxxxi.

108. *Moon and Seven Stars.*

Let fig. 2. be a smooth circular board 6 feet diameter: out of the middle of it cut a circular piece 12 or 14 inches diameter; and over the vacancy put white Persian silk, on which paint a moon's face; then let I, I, I, &c. be stars, each 4 or 5 inches diameter, cut out with five points, and covered with oiled silk: on the front of the large circular board draw a 7-pointed star, as large as the circle will allow; then on the lines which form this star, bore holes, wherein fix pointed stars. When this case is to be fired, it must be fixed upon the front of a post, on a spindle, with a wheel of brilliant fire behind the face of the moon: so that, while the wheel burns, the moon and stars will appear transparent: and when the wheel has burnt out, they will disappear, and the large star in front, which is formed of pointed stars, will begin, being lighted by a pipe of communication from the last case of the vertical wheel, behind the moon; this pipe must be managed in the same manner as those in regulated pieces.

109. *Double Cone-Wheel illuminated.*

This piece is represented by fig. 3. Let A be a strong decagon wheel, 2 feet 6 inches diameter; then on each side of it fix a cone B and C: these cones are to consist of a number of hoops, supported by 3 or 4 pieces of wood, in the manner of the spiral wheels. Let the height of each cone be 3 feet 6 inches; and on all the hoops tie port-fires horizontally, with their mouths outwards, and clothe the wheel with 8-oz. cases, all to play horizontally, two at a time: the cones may be fired with the first or second cases. The spindle for this piece must go through both the cones, and rise three feet above the point of the cone at top; so that its length will be 10 feet 4 inches from the top of the post H, in which it is fixed, allowing four inches for the thickness of the block of the wheel. The whole weight of the wheel and cones must bear on a shoulder in the spindle, on which the block of the wheel must turn.—Near the top of the spindle must be a hole in the front, into which screw a small spindle, after the cones are on: then on this small spindle fix a sun D, composed of fixteen 9-inch 4-oz. cases of brilliant fire; which cases must not be placed on a fell, but only stuck into a block of 6 inches diameter: then in the front of this sun must be a circular vertical wheel, 16 inches diameter; on the front of this wheel form with iron-wire a spiral line, and clothe it with illuminations after the usual method. As this wheel is not to be fired till the cones are burnt out, the method of firing it is thus: Let the hole in the block, at the top of the uppermost cone, be a little larger than the spindle which passes through it. Then, from the first case of the vertical wheel before the sun, carry a leader down the side of the spindle to the top of the block of the horizontal wheel, on which must be a tin barrel; then this leader being met by another brought from the end of the last case of the horizontal wheel, will give fire to the vertical wheel so soon as the cones are extinguished: but the sun D must not be fired till the vertical wheel is quite burnt out.

110. *Fire-pumps.*

Cases for fire-pumps are made as those for tourbillons; only they are pasted, instead of being rolled dry. Having rolled and dried your cases, fill them: first put in a little meal-powder, and then a star; on which ram lightly a ladle or two of composition, then a little meal-powder, and on that a star, then again composition; and so on till you have filled the case. Stars for fire-pumps should not be round; but must be made either square, or flat and circular, with a hole through the middle:

ls,&c. middle: the quantity of powder for throwing the stars must increase as you come near the top of the case; for, if much powder be put at the bottom, it will burst the case. The stars must differ in size in this manner: Let the star which you put in first be about $\frac{1}{4}$ less than the bore of the case; but let the next star be a little larger, and the third star a little larger than the second, and so on: let them increase in diameter till within two of the top of the case, which two must fit in tight. As the loading of fire-pumps is somewhat difficult, it will be necessary to make two or three trials before you depend on their performance: when you fill a number of pumps, take care not to put in each an equal quantity of charge between the stars, so that when they are fired, they may not throw up too many stars together. Cases for fire-pumps should be made very strong, and rolled on 4 or 8 oz. formers, 10 or 12 inches long each.

111. *Vertical Scroll Wheel.*

This wheel may be made of any diameter, but must be constructed as in fig. 4. to do which proceed thus: Have a block made of a moderate size, in which fix four flat spokes, and on them fix a flat circular fell of wood; round the front of this fell place port-fires; then on the front of the spokes form a scroll, either with a hoop or strong iron wire; on this scroll tie cases of brilliant fire, in proportion to the wheel, head to tail, as in the figure. When you fire this wheel, light the first case near the fell; then, as the cases fire successively, you will see the circle of fire gradually diminish: but whether the illuminations on the fell begin with the scroll or not, is immaterial, that being left entirely to the maker.

ate CXXXI.

N. B. This wheel may be put in the front of a regulated piece, or fired by itself, occasionally.

112. *Pin-Wheels.*

First roll some paper pipes, about 14 inches long each; these pipes must not be made thick of paper, two or three rounds of elephant paper being sufficient. When your pipes are thoroughly dried, you must have a tin tube 12 inches long, to fit easy into the pipes; at one end of this tube fix a small conical cup, which cone is called a *funnel;* then bend one end of one of the pipes, and put the funnel in at the other as far as it will reach, and fill the cup with composition: then draw out the funnel by a little at a time, shaking it up and down, and it will fill the pipe as it comes out. Having filled some pipes, have some small blocks made about one inch diameter and half an inch thick: round one of these blocks wind and paste a pipe, and to the end of this pipe join another; which must be done by twisting the end of one pipe to a point, and putting it into the end of the other with a little paste: in this manner join four or five pipes, winding them one upon the other so as to form a spiral line. Having wound on your pipes, paste two slips of paper across them to hold them together: besides these slips of paper, the pipes must be pasted together.

There is another method of making these wheels, viz. by winding on the pipes without paste, and sticking them together with sealing-wax at every half turn; so that when they are fired, the end will fall loose every time the fire passes the wax, by which means the circle of fire will be considerably increased. The formers for these pipes are made from $1\frac{1}{2}$ to 4-16ths of an inch diameter; and the composition for them is as follows: Meal-powder 8 oz. saltpetre 2 oz. and sulphur 1: among these ingredients may be mixed a little steel-filings or the dust of cast iron: this composition should be very dry, and not made too fine, or it will stick in the funnel. These wheels may be fired on a large pin, and held in the hand with safety.

Different Pieces of Fire-works.

113. *Fire-globes.*

There are two sorts of fire-globes; one with projected cases; the other with the cases concealed, thus: Have a globe made of wood, of any diameter you choose, and divide the surface of it into 14 equal parts, and at each division bore a hole perpendicular to the centre: these holes must be in proportion to the cases intended to be used: in every hole except one, put a case filled with brilliant, or any other charge, and let the mouths of the cases be even with the surface of the globe; then cut in the globe a groove, from the mouth of one case to the other, for leaders, which must be carried from case to case, so that they may all be fired together; this done, cover the globe with a single paper, and paint it. These globes may be used to ornament a building.

Fire-globes with projected cases are made thus: Your globe being made with 14 holes bored in it as usual, fix in every hole except one, a case, and let each case project from the globe two-thirds of its length; then clothe all the cases with leaders, so that they may all take fire at the same time. Fire-globes are supported by a pintle, made to fit the hole in which there is no case.

114. *To thread and join Leaders, and place them on different Works.*

Joining and placing leaders is a very essential part of fire-works, as it is on the leaders that the performance of all complex works depends; for which reason the method of conducting pipes of communication shall be here explained in as plain a manner as possible. Your works being ready to be clothed, proceed thus: Cut your pipes of a sufficient length to reach from one case to the other; then put in the quick-match, which must always be made to go in very easy: when the match is in, cut it off within about an inch of the end of the pipe, and let it project as much at the other end; then fasten the pipe to the mouth of each case with a pin, and put the loose ends of the match into the mouths of the cases, with a little meal-powder: this done to all the cases, paste over the mouth of each two or three bits of paper. The preceding method is used for large cases, and the following for small, and for illuminations: First thread a long pipe; then lay it on the tops of the cases, and cut a bit of the under side, over the mouth of each case, so that the match may appear: then pin the pipe to every other case; but before you put on the pipes, put a little meal-powder in the mouth of each case. If the cases thus clothed are port-fires on illuminated works, cover the mouth of each case with a single paper; but if they are choaked cases, situated so that a number of sparks from other works may fall on them before they are fired, secure them with three or four papers, which must be pasted on very smooth, that there may be no creases for the sparks to lodge in, which often set fire to the works before their time. Avoid as much as possible placing the leaders too near, or one across the other so as to touch, as it may happen that the flash of one will

Different Pieces of Fire-works.

will fire the other; therefore if your works should be so formed that the leaders must cross or touch, be sure to make them very strong, and secure at the joints, and at every opening.

When a great length of pipe is required, it must be made by joining several pipes in this manner: Having put on one length of match as many pipes as it will hold, paste paper over every joint; but, if a still greater length is required, more pipes must be joined, by cutting about an inch off one side of each pipe near the end, and laying the quick-match together, and tying them fast with small twine; after which, cover the joining with pasted paper.

115. *Placing Fire-works to be exhibited.*

Nothing adds more to the appearance of fire-works than the placing them properly; though the manner of placing them chiefly depends on the judgment of the maker. The following are the rules generally observed, whether the works are to be fired on a building or on stands: If they are a double set, place one wheel of a sort on each side of the building; and next to each of them, towards the centre, place a fixed piece, then wheels, and so on; leaving a sufficient distance between them for the fire to play from one without burning the other. Having fixed some of your works thus in front, place the rest behind them, in the centre of their intervals: The largest piece, which is generally a regulated or transparent piece, must be placed in the centre of the building, and behind it a sun, which must always stand above all the other works: A little before the building, or stands, place your large gerbes; and at the back of the works fix your marron batteries, *pots des aigrettes*, *pots des brins*, *pots des saucissons*, air-balloons, and flights of rockets: The rocket stands may be fixed behind, or anywhere else, so as not to be in the way of the works.

Single collections are fired on stands; which stands are made in the same manner as theodolite stands, only the top part must be long or short occasionally: these stands may be fixed up very soon without much trouble.

116. *Order of Firing.*

1. Two signal rockets
2. Six sky rockets
3. Two honorary rockets
4. Four caduceus rockets
5. Two vertical wheels illuminated
6. Two spiral wheels illuminated
7. Two transparent stars
8. A line rocket of five changes
9. Four tourbillons
10. Two horizontal wheels
11. Two air balloons illuminated
12. Two Chinese fountains
13. Two regulating pieces of four mutations each
14. Two pots des aigrettes
15. Three large gerbes
16. A flight of rockets
17. Two balloon wheels
18. Two cascades of brilliant fire
19. Twelve sky-rockets
20. Two illuminated yew trees
21. Two air-balloons of serpents, and 2 compound
22. Four tourbillons
23. Two Fruiloni wheels
24. Two illuminated globes with horizontal wheels
25. One pot des saucissons
26. Two plural wheels
27. Marron battery
28. Two chandeliers illuminated
29. Range of pots des brins
30. Twelve sky-rockets
31. Two yew-trees of fire
32. Nest of serpents
33. Two double cones illuminated
34. Regulating piece of seven mutations, viz.
   1. Vertical wheel illuminated
   2. Golden glory
   3. Octagon vertical wheel
   4. Porcupine's quills
   5. Cross fires
   6. Star-piece with brilliant rays
   7. Six vertical wheels
35. Brilliant sun
36. Large flight of rockets.

When water-works are to be exhibited, divide them into several sets, and fire one set after every fifth or sixth change of land and air-works. Observe this rule in firing a double set of works: Always begin with sky-rockets, then two moveable pieces, then two fixed pieces, and so on; ending with a large flight of rockets, or a marron battery: if a single collection, fire a fixed piece after every wheel or two, and now and then some air and water-works.

117. *Fountain of Sky-rockets.*

Plate CCCCX.

Fig. 5. represents a fountain of 30 rockets. Let A be a perpendicular post, 16 feet high from the ground, and 4 inches square. Let the rail, or cross piece C, be 1 foot 6 inches long, 3 inches broad, and 1 thick. The rail D, at bottom, must be 6 feet long, 1 foot broad, and 1 inch thick. F and G are the two sides which serve to supply the rails D, E, H, I, C: these sides are 1 foot broad at bottom, and cut in the front with a regular slope, to 3 inches at top; but their back edges must be parallel with the front of the pots A. The breadth of the rails E, H, I, will be determined by the breadth of the sides: all the rails must be fixed at 2 feet distance from each other, and at right angles with the pots. Having placed the rails thus, bore in the bottom rail 10 holes, at equal distances, large enough to receive the stick of a one-pound rocket: in the back edge of this rail cut a groove from one end to the other, fit to contain a quick-match; then cut a groove in the top of the rail, from the edge of each hole, into the groove in the back: in the same manner cut in the second rail, E, 8 holes and grooves; in the third rail, H, 6 holes and grooves; in the fourth rail, I, 4 holes and grooves; and in the top rail, 2 holes and grooves. B, a rail with holes in it to guide the ends of the rocket-sticks: this rail must be fixed 6 feet from the rail D. The fountain frame being thus made, prepare your rockets thus: Tie round the mouth of each a piece of thin paper, large enough to go twice round, and to project about $1\frac{1}{2}$ inch from the mouth of the rocket, which must be rubbed with wet meal-powder; in the mouth of each rocket put a leader, which secure well with the paper that projects from the mouth of the case: these leaders must be carried into the grooves in

ferent ces of works. in the back of the rails, in which lay a quick-match from one end to the other, and cover it with pafted paper: holes muft be made in the rail D, to receive the ends of the fticks of the rockets in the rail E, and fo on to the fourth rail; fo that the fticks of the rockets at top will go through all the rails. The rockets being fo prepared, fix a gerbe, or white flower-pot, on each rail, before the poft, with their mouths inclining a little forwards: thefe gerbes muft be lighted all at once. Behind or before each gerbe, fix a cafe of brilliant or flow fire: thefe cafes muft be filled fo that they may burn out one after the other, to regulate the fountain; which may be done by carrying a leader from the end of each flow or brilliant fire, into the groove in the back of each rail. Different fixed rockets may be ufed in thefe fountains: but it will be beft to fill the heads of the rockets on each rail with different forts of things, in this manner; thofe at top with crackers, the next with rains, the third with ferpents, the fourth with tailed ftars, and the laft flight with common or brilliant ftars.

118. *Palm Tree.*

This piece, though made of common fires, and of a fimple conftruction, has a very pleafing effect; owing to the fires interfecting fo often, that they refemble the branches of trees. Let A (fig. 6.) be a perpendicular poft, of any thicknefs, fo that it is fufficiently ftrong to hold the cafes; let the diftance from B to C be 2 feet 6 inches, and C to D 2 feet 6 inches, and let the length of each crofs piece be 2 feet; on each end of each fix a five-pointed ftar: then fix, on pegs made on purpofe, 12-inch half-pound cafes of brilliant fire, as in the figure. All the cafes and ftars muft be fired at once. This piece fhould be fixed high from the ground. Plate CCXXXI.

119. *Illuminated Pyramid, with Archimedian Screws, a Globe, and vertical Sun,*

May be of any fize. One made according to the dimenfions of fig. 7. will be a good proportion, whofe height is 21 feet; from C to D, 6 feet; from E to F, 9 feet: the fpace between the rails muft be 6 inches, and the rails as thin as poffible: in all the rails ftick port-fires at four inches diftance. The Archimedian fcrews, G, K, are nothing more than double fpiral wheels, with the cafes placed on their wheels horizontally inftead of obliquely. The vertical fun, I, need not confift of more than 12 rays, to form a fingle glory. The globe at top muft be made in proportion to the pyramid; which being prepared according to the preceding directions, place your leaders fo that all the illuminating port-fires, fcrews, globe, and fun, may take fire together. The pyramid muft be fupported by the two fides, and by a fupport brought from a pole, which muft be placed two feet from the back of the pyramid, that the wheels may run free.

120. *Rofe-piece and Sun.*

A rofe-piece may be ufed for a mutation of a regulated piece, or fired by itfelf: it makes the beft appearance when made large; if its exterior diameter be 6 feet, it will be a good fize. Fig. 8. fhows the manner it appears in before it is fired. Let the exterior fell be made of wood, and fupported by 4 wooden fpokes; all the other parts, on which the illuminations are fixed, muft be made of ftrong iron wire: on the exterior fell place as many half-pound cafes of brilliant charge as you think proper, but the more the better; for the nearer the cafes are placed, the ftronger will be the rays of the fun: the illuminations fhould be placed within 3 inches of each other: they muft all be fired together, and burn fome time before the fun is lighted; which may be done by carrying a leader from the middle of one of the illuminations, to the mouth of one of the fun cafes. Different Pieces of Fire-works.

121. *Tranfparent Stars with illuminated Rays.*

Fig. 9. reprefents an illuminated ftar. Let the diameter from A to B be 2 feet, and from C to D 7 feet. Firft make a ftrong circular back or body of the ftar, 2 feet diameter, to which you fix the illuminated rays: in the centre of the front of the body fix a fpindle, on which put a double triangular wheel, 6 inches diameter, clothed with 2 ounce cafes of brilliant charge: the cafes on this wheel muft burn but one at a time. Round the edge of the body nail a hoop made of thin wood or tin: this hoop muft project in front 6 or 7 inches: in this hoop cut 3 or 4 holes to let out the fmoke from the wheel. The ftar and garter may be cut out of ftrong pafteboard or tin, made in this manner: Cut a round piece of pafteboard or tin, 2 feet diameter, on which draw a ftar, and cut it out; then over the vacancy pafte Perfian filk; paint the letters yellow; 4 of the rays yellow, and 4 red; the crofs in the middle may be painted half red and half yellow, or yellow and blue. This tranfparent ftar muft be faftened to the wooden hoop by a fcrew, to take off and on; the illuminated rays are made of thin wood, with tin fockets fixed on their fides within 4 inches of each other; in thefe fockets ftick illuminating port-fires; behind the point of each ray fix a half-pound cafe of grey, black, or Chinefe fire. Plate CCCCXXXI.

N. B. The illuminated rays to be lighted at the fame time as the triangular wheel, or after it is burnt out; which may be done by a tin barrel being fixed to the wheel, after the manner of thofe in the regulated pieces. Into this barrel carry a leader from the illuminated rays, through the back of the ftar; which leader muft be met by another, brought from the tail of the laft cafe on the wheel.

122. *Tranfparent Table Star illuminated.*

Fig. 1. reprefents a table ftar, whofe diameter, from E to F, is 12 feet; and from E to I, 4 feet. This proportion, obferved on each fide, will make the centre frame 4 feet fquare: in this fquare fix a tranfparent ftar, as in the figure. This ftar may be painted blue, and its rays made as thofe of the flaming ftars defcribed before. The wheel for this ftar may be compofed of different coloured fires, with a charge or two of flow fire; the wheels *a, a, a, a,* may be clothed with any number of cafes, fo that the ftar-wheel confift of the fame: the illuminating port-fires, which muft be placed very near each other on the frames, muft be fo managed as to burn as long as the wheels, and lighted at the fame time. Plate CCCCXXXII.

123. *The regulated illuminated Spiral Piece, with a projected Star-wheel illuminated.*

This piece is reprefented by fig. 2. and is thus made. Have a block made 8 inches diameter; in this block fcrew 6 iron fpokes, which muft ferve for fpindles for the fpiral wheels: thefe wheels are made as ufual, each $1\frac{1}{2}$ foot diameter, and 3 feet in height: the fpindles muft be long enough to keep the wheels 4 or 5 inches from one another: at the end of each fpindle muft be a

Different Pieces of Fire-works.

screw-nut, on which the wheels that hang downwards will run; and on the spindles which stand upwards must be a shoulder, for the blocks of the wheels to run on.

The projected star-wheel must turn on the same spindle on which the large block is fixed; this spindle must be long enough to allow the star-wheel to project a little before the spiral wheels: the exterior diameter of the star-wheel must be 3 feet 5. On this wheel fix 3 circles of iron wire, and on them port-fires; on the block place a transparent star, or a large 5-pointed brilliant star. The cases on this wheel may burn 4 at once, as it will contain near twice the number of one of the spiral wheels: the cases on the spiral wheels must be placed parallel to their fells, and burn two at a time.

125. *A Figure-piece illuminated with five-pointed Stars.*

The construction of this piece is very easy, as shown by fig. 3. whose diameter from B to C is 8 feet, and from D to F 2 feet: the vertical wheel in the centre must be 1 foot diameter, and consist of 6 four-ounce cases of different coloured charge, which cases must burn double: on the frames fix 5 pointed brilliant or blue stars, rammed 4 inches with composition: let the space between each star be 8 inches; at each point fix a gerbe, or case of Chinese fire. When to be fired, let the gerbe, stars, and wheel, be lighted at the same time.

Plate CCCCXXXII.

125. *The Star-wheel illuminated.*

This beautiful piece is shown by fig. 4. Its exterior fell is made of wood, 3 feet 6, or 4 feet diameter; within this fell, form with iron wire 3 circles, one less than the other, so that the diameter of the least may be about 10 inches: place the port-fires on these fells with their mouths inclining outwards, and the port-fires on the points of the star with their mouths projecting in front: let the exterior fell be clothed with 4 ounce cases of grey charge: these cases must burn 4 at a time, and be lighted at the same time as the illuminations.

126. *Pyramid of Flower-pots.*

Fig. 5. represents this curious piece, which must be made thus. Let the distance from A to B be 6 feet; and from one rail to the other, 2: on the bottom rail fix 5 paper mortars, each $3\frac{1}{2}$ inches diameter; these mortars load with serpents, crackers, stars, &c.

In the centre of each mortar fix a case of spur-fire: on the second rail fix 4 mortars, so as to stand exactly in the middle of the intervals of them on the bottom rail; on the third rail place 3 mortars; on the fourth, 2; and on the top of the posts, 1: the bottom rail must be 6 feet long: all the mortars must incline a little forwards, that they may easily discharge; and the spur-fires rammed exactly alike, that the mortars may all be fired at the same time. Having prepared your pyramid according to the preceding directions, carry pipes of communication from one spur-fire to the other.

127. *The illumimated Regulating Piece.*

Fig. 6. represents one half of this piece. A, A, A, A, are flat wooden spokes, each 5 feet long: at the end of each place a vertical wheel, 10 inches diameter, clothed with 6 four-ounce cases of brilliant fire: these cases must burn but 1 at a time: on two of the spokes of each wheel place 2 port-fires, which must be lighted with the first case of the wheel; on each spoke A, A, &c. behind the wheels, place 6 cases of the same size with those on the wheels: these cases must be tied across the spokes with their mouths all one way, and be made to take fire successively one after the other, so that they may assist the whole pieces to turn round.

The diameter of the large wheel must be $2\frac{1}{2}$ feet; and its fell made of wood, which must be fixed to the large spokes: on this wheel place 24 cases of the same sort with those on the small wheels; these cases must burn 4 at a time: in this wheel make 3 circles with iron wire, and on them place illuminating port-fires, as in the figure: the star-points on the large spokes may be made of thin ash-hoops; the diameter of these points close to the centre-wheel must be 11 inches: on these points place port-fires, at $3\frac{1}{2}$ inches distance one from the other.

Fig. 7. represents the blocks of this piece. The diameters of these blocks, at A and B, must be 8 inches; and C and D, $4\frac{1}{2}$ inches: the length of each of these blocks must be 6 inches: at the small ends of these blocks fix an iron wheel 5 inches diameter, which wheels must have teeth, to turn the wheel E: this wheel is fixed on a small spindle screwed into the large spindle, which goes through the two blocks, and on which they run.

Supposing fig. 6. to be on the block A, in fig. 7. and to turn to the right, and another piece of the same construction on the block B, with its fires placed so as to turn it to the left; you will find them move very true and fast, by the help of the 3 iron wheels, which serve to regulate their motions, as well as to assist them in turning: let the iron circles in the front of the great wheels be of different diameters, so that when fired there may appear 6 circles. When this piece is fired, all the wheels and illuminations must be lighted at one time.

Sect. VI. *Aquatic Fire-works.*

Works that sport in the water are much esteemed by most admirers of fire-works, particularly water-rockets; and as they seem of a very extraordinary nature to those who are unacquainted with this art, they merit a particular explanation.

128. *Water-rockets,*

May be made from 4 oz. to 2 lb. If larger, they are too heavy; so that it will be difficult to make them keep above water without a cork float, which must be tied to the neck of the case; but the rockets will not dive so well with as without floats.

Cases for these are made in the same manner and proportion as sky-rockets, only a little thicker of paper. When you fill those which are drove solid, put in first 1 ladleful of slow fire, then 2 of the proper charge, and on that 1 or 2 ladles of sinking charge, then the proper charge, then the sinking charge again, and so on, till you have filled the case within 3 diameters; then drive on the composition 1 ladleful of clay; through which make a small hole to the charge; then fill the case, within $\frac{1}{2}$ a diameter, with corn-powder, on which turn down 2 or 3 rounds of the case in the inside; then pinch and tie the end very tight; having filled your rockets (according to the above directions), dip their ends in melted rosin or sealing wax, or else secure them well with grease. When you fire those rockets, throw in 6 or 8 at a time; but, if you would have them all sink, or swim, at the same time,

time, you muſt drive them with an equal quantity of compoſition, and fire them all together.

129. *To make Pipes of Communication, which may be uſed under Water.*

Pipes for this purpoſe muſt be a little thicker of paper than thoſe for land. Having rolled a ſufficient number of pipes, and kept them till dry, waſh them over with drying oil, and ſet them to dry; but when you oil them, leave about $1\frac{1}{2}$ inch at each end dry, for joints: if they were oiled all over, when you come to join them, the paſte would not ſtick where the paper is greaſy: after the leaders are joined, and the paſte dry, oil the joints. Theſe pipes will lie many hours under water, without receiving any damage.

130. *Horizontal Wheels for the Water.*

Firſt get a large wooden bowl without a handle; then have an octagon wheel made of a flat board 18 inches diameter, ſo that the length of each ſide will be near 7 inches; in all the ſides cut a groove for the caſes to lie in. This wheel being made, nail it on the top of the bowl; then take 4-eight oz. caſes, filled with a proper charge, each about 6 inches in length. Now, to clothe the wheel with theſe caſes, get ſome whitiſh-brown paper, and cut it into ſlips 4 or 5 inches broad and 7 or 8 long: theſe ſlips being paſted all over on one ſide, take one of the caſes, and roll one of the ſlips of paper about $1\frac{1}{2}$ inch on its end, ſo that there will remain about $2\frac{1}{2}$ inches of the paper hollow from the end of the caſe: this caſe tie on one of the ſides of the wheel, near the corners of which muſt be holes bored, through which you put the packthread to tie the caſes: having tied on the firſt caſe at the neck and end, put a little meal-powder in the hollow paper; then paſte a ſlip of paper on the end of another caſe, the head of which put into the hollow paper on the firſt, allowing a ſufficient diſtance from the tail of one to the head of the other for the paſted paper to bend without tearing: the ſecond caſe tie on as you did the firſt: and ſo on with the reſt, except the laſt, which muſt be cloſed at the end, unleſs it is to communicate to any thing on the top of the wheel, ſuch as fire-pumps or brilliant fires, fixed in holes cut in the wheel, and fired by the laſt or ſecond caſe, as the fancy directs: 6, 8, or any number, may be placed on the top of the wheel, provided they be not too heavy for the bowl.

Before you tie on the caſes, cut the upper part of all their ends, except the laſt, a little ſhelving, that the fire from one may play over the other, without being obſtructed by the caſe. Wheel-caſes have no clay drove in their ends, nor pinched, but are always left open, only the laſt, or thoſe which are not to lead fire, which muſt be well ſecured.

131. *Water Mines.*

For theſe mines you muſt have a bowl with a wheel on it, made in the ſame manner as the water-wheel; only in its middle there muſt be a hole, of the ſame diameter you deſign to have the mine. Theſe mines are tin pots, with ſtrong bottoms, and a little more than 2 diameters in length: your mine muſt be fixed in the hole in the wheel, with its bottom reſting on the bowl; then loaded with ſerpents, crackers, ſtars, ſmall water-rockets, &c. in the ſame manner as pots of aigrettes; but in their centre fix a caſe of Chineſe fire, or a ſmall gerbe, which muſt be lighted at the beginning of the laſt caſe on the wheel. Theſe wheels are to be clothed as uſual.

132. *Fire-globes for the Water.*

Bowls for water-globes muſt be very large, and the wheels on them of a decagon form: on each ſide of which nail a piece of wood 4 inches long; and on the outſide of each piece cut a groove, wide enough to receive about $\frac{1}{4}$ of the thickneſs of a 4-oz. caſe: theſe pieces of wood muſt be nailed in the middle of each face of the wheel, and fixed in an oblique direction, ſo that the fire from the caſes may incline upwards: the wheel being thus prepared, tie in each groove a 4-oz. caſe, filled with a grey charge; then carry a leader from the tail of one caſe to the mouth of the other.

Globes for theſe wheels are made of 2 tin hoops, with their edges outwards, fixed one within the other, at right angles. The diameter of theſe hoops muſt be ſomewhat leſs than that of the wheel. Having made a globe, drive in the centre of a wheel an iron ſpindle, which muſt ſtand perpendicular, and its length 4 or 6 inches more than the diameter of the globe.

This ſpindle ſerves for an axis, on which the globe is fixed, which, when done, muſt ſtand 4 or 6 inches from the wheel: round one ſide of each hoop muſt be ſoldered little bits of tin, $2\frac{1}{2}$ inches diſtance from each other; which pieces muſt be 2 inches in length each, and only faſtened at one end, the other ends being left looſe, to turn round the ſmall port-fires, and hold them on: theſe port-fires muſt be made of ſuch a length as will laſt out the caſes on the wheel. You are to obſerve, that there need not be any port-fires at the bottom of the globe within 4 inches of the ſpindle; for, if there were, they would have no effect, but only burn the wheel: all the port-fires muſt be placed perpendicular from the centre of the globe, with their mouths outwards; and muſt all be clothed with leaders, ſo as all to take fire with the ſecond caſe of the wheel; which caſes muſt burn two at a time, one oppoſite the other. When two caſes of a wheel begin together, two will end together; therefore the two oppoſite end caſes muſt have their ends pinched and ſecured from fire. The method of firing ſuch wheels is, by carrying a leader from the mouth of one of the firſt caſes to that of the other; which leader being burnt through the middle, will give fire to both at the ſame time.

133. *Odoriferous Water Balloons.*

Theſe balloons are made in the ſame manner as air-balloons, but very thin of paper, and in diameter $1\frac{3}{4}$ inch, with a vent of $\frac{1}{4}$ inch diameter. The ſhells being made, and quite dry, fill them with any of the following compoſitions, which muſt be rammed in tight: theſe balloons muſt be fired at the vent, and put into a bowl of water. Odoriferous works are generally fired in rooms.

Compoſition I. Saltpetre 2 oz. flour of ſulphur 1 oz. camphor $\frac{1}{2}$ oz. yellow amber $\frac{1}{4}$ oz. charcoal-duſt $\frac{1}{2}$ oz. flour of benjamin or aſſa odorata $\frac{1}{4}$ oz. all powdered very fine and well mixed.

II. Saltpetre 12 oz. meal-powder 3 oz. frankincenſe 1 oz. myrrh $\frac{1}{2}$ oz. camphor $\frac{1}{2}$ oz. charcoal 3 oz. all moiſtened with the oil of ſpike.

III. Saltpetre 2 oz. ſulphur $\frac{1}{2}$ oz. antimony $\frac{1}{2}$ oz. amber $\frac{1}{2}$ oz. cedar raſpings $\frac{1}{2}$ oz. all mixed with the oil of roſes and a few drops of bergamot.

IV.

Aquatic Fire-works.

IV. Saltpetre 4 oz. sulphur 1 oz. saw-dust of juniper ½ oz. saw-dust of cypress 1 oz. camphor ½ oz. myrrh 2 drams, dried rosemary ¼ oz. cortex elaterii ½ oz. all moistened a little with the oil of roses.

N. B. Water rockets may be made with any of the above compositions, with a little alteration, to make them weaker or stronger, according to the size of the cases.

134. *Water Balloons.*

Having made some thin paper shells, of what diameter you please, fill some with the composition for water balloons, and some after this manner: Having made the vent of the shells pretty large, fill them almost full with water rockets, marrons, squibs, &c. Then put in some blowing powder, sufficient to burst the shells; and afterwards fix in the vent a water-rocket, long enough to reach the bottom of the shell, and its neck to project a little out of the vent; this rocket must be open at the end, to fire the powder in the shell, which will burst the shell, and disperse the small rockets, &c. in the water. When you have well secured the large rocket in the vent of the shell, take a cork float with a hole in its middle, which fit over the head of the rocket, and fasten it to the shell: this float must be large enough to keep the balloon above water.

135. *Water Squibs*

Are generally made of 1-oz. serpent cases seven or eight inches long, filled two thirds with charge, and the remainder bounced. The common method of firing them is this: Take a water-wheel, with a tin mortar in its centre, which load with squibs after the usual method; but the powder in the mortar must be no more than will just throw the squibs out easily into the water: you may place the cases on the wheel either obliquely or horizontally; and on the top of the wheel, round the mortar, fix six cases of brilliant fire perpendicular to the wheel: these cases must be fired at the beginning of the last case of the wheel, and the mortar at the conclusion of the same.

136. *A Sea-fight with small Ships, and to prepare a Fire-ship for it.*

Having procured four or five small ships, of two or three feet in length, (or as many as you design to fight), make a number of small reports, which are to serve for guns. Of these range as many as you please on each side of the upper decks; then at the head and stern of each ship fix a two-ounce case, eight inches long, filled with a slow port-fire receipt; but take care to place it in such a manner that the fire may fall in the water, and not burn the rigging: in these cases bore holes at unequal distances from one another, but make as many in each case as half the number of reports, so that one case may fire the guns on one side, and the other those on the opposite. The method of firing the guns is, by carrying a leader from the holes in the cases to the reports on the decks; you must make these leaders very small, and be careful in calculating the burning of the slow-fire in the regulating cases, that more than two guns be not fired at a time. When you would have a broadside given, let a leader be carried to a cracker, placed on the outside of the ship; which cracker must be tied loose, or the reports will be too slow: in all the ships put artificial guns at the port-holes.

Having filled and bored holes in two port-fires for regulating the guns in one ship, make all the rest exactly the same; then, when you begin the engagement, light one ship first, and set it a sailing, and so on with the rest, sending them out singly, which will make them fire regularly, at different times, without confusion; for the time between the firing of each gun will be equal to that of lighting the slow fires.

The fire-ship may be of any size; and need not be very good, for it is always lost in the action. To prepare a ship for this purpose, make a port-fire equal in size with those in the other ships, and place it at the stern; in every port place a large port-fire, filled with a very strong composition, and painted in imitation of a gun, and let them all be fired at once by a leader from the slow fire, within two or three diameters of its bottom; all along both sides, on the top of the upper deck, lay star-composition about half an inch thick and one broad, which must be wetted with thin size, then primed with meal-powder, and secured from fire by pasting paper over it; in the place where you lay this composition, drive some little tacks with flat heads, to hold it fast to the deck: this must be fired just after the sham guns, and when burning will show a flame all round the ship: at the head take up the decks, and put in a tin mortar loaded with crackers, which mortar must be fired by a pipe from the end of the slow fire; the firing of this mortar will sink the ship, and make a pretty conclusion. The regulating port-fire of this ship must be lighted at the same time with the first fighting ship.

Having prepared all the ships for fighting, we shall next proceed with the management of them when on the water. At one end of the pond, just under the surface of the water, fix two running blocks, at what distance you choose the ships should fight; and at the other end of the pond, opposite to each of these blocks, under the water, fix a double block; then on the land, by each of the double blocks, place two small windlasses; round one of them turn one end of a small cord, and the other end put through one of the blocks; then carry it through the single one at the opposite end of the pond, and bring it back through the double block again, and round the other windlass: to this cord, near the double block, tie as many small strings as half the number of the ships, at what distance you think proper; but these strings must not be more than two feet each: make fast the loose end of each to a ship, just under her bow-sprit; but if tied to the keel, or too near the water, it will overset the ship. Half the ships being thus prepared, near the other double block fix two more windlasses, to which fasten a cord, and to it tie the other half of the ships as before: when you fire the ships, pull in the cord with one of the windlasses, to get all the ships together; and when you have set fire to the first, turn that windlass which draws them out, and so on with the rest, till they are all out in the middle of the pond; then, by turning the other windlass, you will draw them back again; by which method you may make them change sides, and tack about backwards and forwards at pleasure. For the fire-ship, fix the blocks and windlasses between the others; so that when she sails out, she will be between the other ships: you must not let this ship advance till the guns at her ports take fire.

137. *To fire Sky-rockets under Water,*

You must have stands made as usual, only the rails must

Aquatic Fire-works.

must be placed flat instead of edgewise, and have holes in them for the rocket-sticks to go through; for if they were hung upon hooks, the motion of the water would throw them off: the stands being made, if the pond is deep enough, sink them at the sides so deep, that, when the rockets are in, their heads may just appear above the surface of the water; to the mouth of each rocket fix a leader, which put through the hole with the stick; then a little above the water must be a board, supported by the stand, and placed along one side of the rockets; then the ends of the leaders are turned up through holes made in this board, exactly opposite the rockets. By this means you may fire them singly or all at once. Rockets may be fired by this method in the middle of a pond, by a Neptune, a swan, a water-wheel, or any thing else you choose.

138. *To represent Neptune in his Chariot.*

To do this to perfection, you must have a Neptune (made of wood, or basket work) as big as life, fixed on a float large enough to bear his weight; on which must be two horses heads and necks, so as to seem swimming, as shown by fig. 11. For the wheels of the chariot, there must be two vertical wheels of black fire, and on Neptune's head a horizontal wheel of brilliant fire, with all its cases, to play upwards. When this wheel is made, cover it with paper or pasteboard, cut and painted like Neptune's coronet; then let the trident be made without prongs, but instead of them, fix three cases of a weak grey charge, and on each horse's head put an eight ounce case of brilliant fire, and on the mouth of each fix a short case, of the same diameter, filled with the white-flame receipt, enough to last out all the cases on the wheels: these short cases must be open at bottom, that they may light the brilliant fires; for the horses eyes put small port-fires, and in each nostril put a small case filled half with grey charge, and the rest with port-fire composition.

If Neptune is to give fire to any building on the water; at his first setting out, the wheels of the chariot, and that on his head, with the white flames on the horses heads, and the port-fires in their eyes and nostrils, must all be lighted at once; then from the bottom of the white flames carry a leader to the trident. As Neptune is to advance by the help of a block and cord, you must manage it so as not to let him turn about, till the brilliant fires on the horses and the trident begin; for it is by the fire from the horses (which plays almost upright) that the building, or work, is lighted; which must be thus prepared. From the mouth of the case which is to be first fired, hang some loose quick-match to receive the fire from the horses. When Neptune is only to be shown by himself, without setting fire to any other works, let the white flames on the horses be very short, and not to last longer than one case of each wheel, and let two cases of each wheel burn at a time.

139. *Swans and Ducks in Water.*

If you would have the swans or ducks discharge rockets into the water, they must be made hollow, and of paper, and filled with small water rockets, with some blowing powder to throw them out: but if this is not done, they may be made of wood, which will last many times. Having made and painted some swans, fix them on floats: then in the places where their eyes should be, bore holes two inches deep, inclining downwards, and wide enough to receive a small port-fire; the port-fire cases for this purpose must be made of brass, two inches long, and filled with a slow bright charge. In the middle of one of these cases make a little hole; then put the port-fire in the eye-hole of the swan, leaving about half an inch to project out; and in the other eye put another port-fire, with a hole made in it: then in the neck of the swan, within two inches of one of the eyes, bore a hole slantwise, to meet that in the port-fire; in this hole put a leader, and carry it to a water-rocket, that must be fixed under the tail with its mouth upwards. On the top of the head place two 1-oz. cases, four inches long each, drove with brilliant fire; one of these cases must incline forwards, and the other backwards: these must be lighted at the same time as the water-rocket; to do which, bore a hole between them in the top of the swan's head, down to the hole in the port-fire, to which carry a leader: if the swan is filled with rockets, they must be fired by a pipe from the end of the water-rocket under the tail. When you set the swan a swimming, light the two eyes.

140. *Water Fire-fountains.*

To make a fire-fountain, you must first have a float made of wood, three feet diameter; then in the middle fix a round perpendicular post, four feet high, and two inches diameter; round this post fix three circular wheels made of thin wood, without any spokes. The largest of these wheels must be placed within two or three inches of the float, and must be nearly of the same diameter. The second wheel must be 2 feet 2 inches diameter, and fixed at two feet distance from the first. The third wheel must be 1 foot 4 inches diameter, and fixed within six inches of the top of the post: the wheels being fixed, take 18 four or eight oz. cases of brilliant fire, and place them round the first wheel with their mouths outwards, and inclining downwards; on the second wheel place 13 cases of the same, and in the same manner as those on the first; on the third, place 8 more of these cases, in the same manner as before, and on the top of the post fix a gerbe; then clothe all the cases with leaders, so that both they and the gerbe may take fire at the same time. Before you fire this work, try it in the water to see if the float is properly made, so as to keep the fountain upright.

PYROTICS, in medicine, caustics, or remedies either actually or potentially hot; and which accordingly will burn the flesh, and raise an eschar. See CAUSTICITY.

PYRRHICHA, in antiquity, a kind of exercise on horseback, or a feigned combat, for the exercise of the cavalry.

It was thus called from its inventor Pyrrhichus, or Pyrrhus of Cydonia, who first taught the Cretans to march in measure and cadence to battle, and to ob-

serve

ſerve the pace of the Pyrrhic foot.—Others derive the name from Pyrrhus the ſon of Achilles, who inſtituted this exerciſe at the obſequies of his father.—Ariſtotle ſays, that it was Achilles himſelf who invented it.

The Romans alſo called it *ludus Trojanus*, "the Trojan game;" and Aulus Gellius, *decurſus*.—It is doubtleſs this exerciſe that we ſee repreſented on medals by two cavaliers in front running with lancets, and the word *decurſio* in the exergum.

PYRRHICHIUS, in the Greek and Latin poetry, a foot conſiſting of two ſyllables, both ſhort;—as, *Deus*.—Among the ancients this foot is alſo called *periambus*; by others *hegemona*.

PYRRHO, a Greek philoſopher, born at Elis in Peloponneſus, flouriſhed about 300 B. C. He was the diſciple of Anaxarchus, whom he accompanied as far as India, where he converſed with the Brachmans and Gymnoſophiſts. He had made painting his profeſſion before he devoted himſelf to the ſtudy of philoſohpy. He eſtabliſhed a ſect whoſe fundamental principle was, That there is nothing true or falſe, right or wrong, honeſt or diſhoneſt, juſt or unjuſt; or that there is no ſtandard of any thing beyond law or cuſtom, and that uncertainty and doubt belong to ever thing. From this continual ſeeking after truth and never finding it, the ſect obtained the name of *Sceptics* or *Pyrrhonians* from the founder, who is ſaid to have acted upon his own principles, and to have carried his ſcepticiſm to ſuch a ridiculous extreme, that his friends were obliged to accompany him wherever he went, that he might not be run over by carriages, or fall down precipices. If this was true, it was not without reaſon that he was ranked among thoſe whoſe intellects were diſturbed by intenſe ſtudy. But it is treated by a modern writer as a mere calumny invented by the dogmatiſts; and we are ſtrongly inclined to be of his opinion, (ſee SCEPTICS.) Pyrrho died about the 90th year of his age, when his memory was honoured with a ſtatue at Athens, and a monument erected to him in his own country.

PYRRHUS, the name of two kings of EPIRUS. See that article.

PYRUS, the PEAR-TREE: A genus of the pentagynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid; there are five petals; the fruit is an apple, inferior, quinquelocular, and polyſpermous. To this genus Linnæus has joined the apple and quince; but, on account of the remarkable difference between the fruits, the laſt is treated under the article CYDONIA. The other ſpecies are,

1. The communis, or common pear-tree, riſes with an upright large trunk, branching 30 or 40 feet high, in ſome widely around, in others more erectly, and forming a conical head; oval, lanceolated, ſerrated leaves, and corymbous cluſters of white flowers from the ſides of the branches, ſucceeded by large fruit extended at the baſe. Under this ſpecies are comprehended almoſt endleſs varieties, all bearing the above deſcription. They bear their flowers and fruit upon ſpurs, ariſing from the ſides of the branches from two or three years old and upwards; the ſame branches and ſpurs continuing fruitful for a great number of years. The different varieties furniſh fruit for uſe from the beginning of July till the months of May and June, next year; which, according to their times of ripening may be divided into three claſſes, ſummer-pears, autumn-pears, and winter-pears. The ſummer-pears ripen in different ſorts from the beginning of July until the middle or end of September, and are generally fit to eat from the tree, or at leaſt do not keep a week or two before they rot. The autumn pears come to their perfection in October, November, and December; ſome ripening nearly on the tree in October and the beginning of November, others requiring to lie ſome time in the fruitery, while ſome will keep two months: but all the winter-pears, though they attain their full growth on the tree by the end of October and in November, yet they do not acquire perfection for eating till from the end of November to April and May. Thoſe of each claſs have different properties; ſome being melting, others breaking, ſome mealy, and ſome hard and auſtere, fit only for kitchen uſes. As many of the fineſt ſorts were firſt obtained from France, they are ſtill continued in moſt catalogues by French names.

2. The malus, or common apple-tree, grows 20 or 30 feet high, having oval ſerrated leaves, and ſeſſile umbels of whitiſh red flowers, ſucceeded by large, roundiſh, and oblong fruit, concave at the baſe. The apple is compoſed of four diſtinct parts, viz. the pill, the parenchyma, the branchery, and the core. The pill or ſkin is only a dilatation of the outermoſt ſkin or rind of the bark of the branch on which it grew. The parenchyma or pulp, as tender and delicious as it is found, is only a dilatation, or, as Dr Grew calls it, *a ſwelth* or ſuperbience of the inner part of the bark of the branch. This appears not only from the viſible continuation of the bark from the one through the pedicle or ſtalk to the other, but alſo from the ſtructure common to both. The branchery or veſſels are only ramifications of the woody part of the branch, ſent throughout all the parts of the parenchyma, the greater branches being made to communicate with each other by inoſculations of the leſs. The apple core is originally from the pith of the branch; the ſap of which finding room enough in the parenchyma through which to diffuſe itſelf, quits the pith, which by this means hardens into core. The varieties of this ſpecies are amazingly great with reſpect to the differences of the fruit. The botaniſts contend, that the wilding, or crab-apple of the woods and hedges, is the original kind, and from the ſeeds of which the cultivated apple was firſt obtained. The varieties of this laſt no doubt are multiplied to ſome hundreds in different places, having been all firſt accidentally obtained from the ſeed or kernels of the fruit, and the approved ſorts continued and increaſed by grafting upon crabs or any kind of apple-ſtocks: but although the number of varieties is very conſiderable, there are not above 40 or 50 ſorts retained in the nurſerymens catalogue. Theſe varieties arrive at full growth in ſucceſſive order from July to the end of October, improve in perfection after being gathered; and ſeveral of the winter kinds, in particular, keep good for many months, even till the arrival of apples next ſummer.

Among theſe various kinds of apples, ſome are uſed for the deſſert, ſome for the kitchen, and ſome for cy-

Pyrus, Pythagoras.

der-making. Thoſe uſed for the deſſert are the following, placed as they ſucceſſively ripen after one another: The white juncating, the margaret apple, the ſummer pearmain, the ſummer queening, the embroidered apple, the golden rennet, the ſummer white calville, the ſummer red calville, the ſilver pippen, the aromatic pippen, *la reinette griſe*, *la haute bonte*, the royal ruſſetting, Wheeler's ruſſet, Sharp's ruſſet, the ſpine apple, the golden pippen, the nonpareil, the *l'api* or *pomme d'api*. Thoſe for the kitchen uſe, in the order of their ripening, are theſe: The codling, the ſummer marygold, the ſummer red pearmain, the Holland pippen, the Kentiſh pippen, the courpendu, Loan's pearmain, the French rennet, the French pippen, the royal ruſſet, the monſtrous rennet, the winter pearmain, the *pome violette*, Spencer's pippen, the ſtone pippen, and the oaken pippen. Theſe moſt eſteemed for cyder are, the Devonſhire royal wilding, the redſtreak apple, the whitſour, the Herefordſhire under-leaf, and the John apple, or *deux annes*, everlaſting hanger, and gennet moyle.

The juice of apples is a menſtruum for iron. A ſolution of iron in the juice of the apples called *golden rennets*, evaporated to a thick conſiſtence, proves an elegant chalybeate, which keeps well.

The beſt method of preſerving apples for winter uſe, is to let them hang upon the trees until there is danger of froſt, to gather them in dry weather, and then to lay them in large heaps to ſweat for a month or ſix weeks. They ought then to be carefully looked over, all which have the leaſt appearance of decay taken out, the ſound fruit wiped dry, and packed up in large oil jars, which have been thoroughly ſcalded and dry, and then ſtopped cloſe to exclude the air. If this plan is duly obſerved, the fruit will keep a long time ſound, and their fleſh remain plump; whereas, when expoſed to the air, their ſkins will ſhrivel, and their pulp ſoften.

3. The coronaria, or ſweet-ſcented crab of Virginia, grows 12 or 15 feet high, having angular, ſerrated leaves, pedunculated umbels of whitiſh-red, ſweet-ſcented flowers, ſucceeded by ſmall round crabs, remarkably ſour and auſtere. There is one variety, called the *evergreen Virginian crab tree*.

Culture. All the varieties of the pear-tree are hardy, and will ſucceed in any common ſoil of a garden or orchard. They are propagated by grafting and budding upon any kind of pear-ſtocks; alſo occaſionally upon quince-ſtocks, and ſometimes upon white-thorn ſtocks; but pear-ſtocks are greatly preferable to all others for general uſe.—All kinds of apples are propagated in the ſame manner; uſing apple-ſtocks inſtead of pear-ſtocks. They will ſucceed in any common ſoil of a garden or orchard, and in any free ſituation except in a low and very moiſt ſoil, in which they are apt to canker, and very ſoon go off. In a friable loam they are generally very ſucceſsful.

PYTHAGORAS, a celebrated philoſopher of antiquity, reſpecting the time and place of whoſe birth the learned are much divided. Eratoſthenes aſſerts, that in the 48th Olympiad*, when he was very young, he was a victor at the Olympic games. Hence Dr Bentley † determines the date of his birth to be the 4th year of the 43d Olympiad; whilſt Lloyd ‡, who denies that the Olympic victor was the ſame perſon with the philoſopher, places it about the 3d year of the 48th Olympiad. Mr Dodwell § differs from both, and wiſhes to fix the birth of Pythagoras in the 4th year of the 52d Olympiad. Of the arguments of theſe learned writers, Le Clerc has given a ſummary in the *Bibliotheque Choiſée*, tom. x. p. 81. &c. and from a review of the whole, it would appear that he was not born earlier than the 4th year of the 43d Olympiad, nor later than the 4th year of the 52d; but in what particular year of that period his birth took place, cannot with any degree of certainty be aſcertained. It is generally believed that he was born in the iſland of Samos, and that he flouriſhed about 500 years before Chriſt, in the time of Tarquin the laſt king of Rome *. His father Mneſarchus, who is thought by ſome to have been a lapidary, and by others a merchant of Tyre, appears to have been a man of ſome diſtinction, and to have beſtowed upon his ſon the beſt education.

...n. ante ...c. 588. † Diſſert. on Ep. of Phalaris. ‡ Chron. of Pythagoras. § Two Diſſertations on Age of ...ereus Pythagoras.

** Tuſc. Queſt. lib. iv. cap. 1.*

Jamblicus † relates a number of wonderful ſtories reſpecting Pythagoras's deſcent from Jupiter, his birth, and early life; and repreſents him even in his youth as a prodigy of wiſdom and manly ſerioufneſs. But moſt of theſe idle tales confute themſelves, afford nothing of importance to be depended upon, and only prove the credulity, careleſſneſs, and prejudice of their author. Of his childhood and early education we know nothing, except that he was firſt inſtructed in his own country by Creophilus, and afterwards in Scyrus by Pherecydes (ſee PHERECYDES). According to the cuſtom of the times he was made acquainted with poetry and muſic; eloquence and aſtronomy became his private ſtudies, and in gymnaſtic exerciſes he often bore the palm for ſtrength and dexterity. He firſt diſtinguiſhed himſelf in Greece at the Olympic games, where, beſide gaining the prize, he is ſaid to have excited the higheſt admiration by the elegance and dignity of his perſon, and the brilliancy of his underſtanding.

† Vit. Pythag. n. 6.

Soon after his appearance at theſe games Pythagoras commenced his travels in queſt of knowledge. He firſt viſited Egypt, where, through the intereſt of Polycrates tyrant of Samos, he obtained the patronage of Amaſis king of Egypt, by whoſe influence, combined with his own aſſiduity, patience, and perſeverance, he at length gained the confidence of the prieſts; from whom he learned their ſacred myſteries, theology, and the whole ſyſtem of ſymbolical learning. In Egypt, too, he became acquainted with geometry and the true ſolar ſyſtem; and, before he left that country, made himſelf maſter of all the learning for which it was ſo famed among the nations of antiquity.

He afterwards viſited Perſia and Chaldea, where from the Magi he learnt divination, the interpreting of dreams, and aſtronomy. He is likewiſe ſaid to have travelled into India, to have converſed with the Gymnoſophiſts, and to have acquired from them a knowledge of the philoſophy and literature of the eaſt; and ſuch was his ardour in the purſuit of ſcience, that in queſt of it, we are told by Cicero *, he croſſed many ſeas, and travelled on foot through many barbarous nations.

** De Finibus, lib. iv. § 29.*

After Pythagoras had ſpent many years in gathering information on every ſubject, eſpecially reſpecting the nature of the gods, the rites of religion, and the immortality of the human ſoul, he returned to his native iſland, and attempted to make his knowledge uſeful by inſtituting a ſchool for the inſtruction of his countrymen. Failing of ſucceſs in this laudable undertaking, he repaired

repaired to Delos, where he pretended to receive moral dogmas from the priestess of Apollo. He also visited Crete, where he was initiated into the most sacred mysteries of Greece. He went likewise to Sparta and Elis, and again assisted at the Olympic games; where in the public assembly he was saluted with the title of *sophist* or *wise man*, which he declined for one more humble. See PHILOLOGY, n° 1. and PHILOSOPHY n° 1.

He returned to Samos enriched with mythological learning and mysterious rites, and again instituted a school. His mysterious symbols and oracular precepts made this attempt more successful than the former had been; but meeting with some opposition, or being detected in some pious frauds, he suddenly left Samos, retired to Magna Grecia, and settled at Crotona.

Here he founded the Italic sect (see PHILOSOPHY n° 20.); and his mental and personal accomplishments, the fame of his distant travels, and his Olympic crown, soon procured him numerous pupils. His bold and manly eloquence and graceful delivery attracted the most dissolute, and produced a remarkable change in the morals of the people of Crotona. His influence was increased by the regularity of his own example, and its conformity to his precepts. He punctually attended the temples of the gods, and paid his devotions at an early hour; he lived upon the purest and most innocent food, clothed himself like the priests of Egypt, and by his continual purifications and regular offerings appeared to be superior in sanctity to the rest of mankind. He endeavoured to assuage the passions of his scholars with verses and numbers, and made a practice of composing his own mind every morning, by playing on his harp, and singing along with it the pæans of Thales. To avoid the temptations of ease and the seductions of idleness, bodily exercises also made a considerable part of his discipline.

At Crotona he had a public school for the general benefit of the people, in which he taught them their duty, praising virtue and condemning vice; and particularly instructing them in the duties of social life. Beside this, he had a college in his own house, which he denominated κοινοβιον. in which there were two classes of students, viz. ἐξωτερικοι, who were also called *auscultantes* and ἐσωτερικοι. The former of these were probationers, and were kept under a long examen. A silence of five years was imposed upon them; which Apuleius thinks was intended to teach them modesty and attention; but Clemens Alexandrinus thinks it was for the purpose of abstracting their minds from sensible objects, and inuring them to the pure contemplation of the Deity. The latter class of scholars were called *genuini, perfecti, mathematici*, and, by way of eminence, *Pythagoreans*. They alone were admitted to the knowledge of the arcana and depths of Pythagoric discipline, and were taught the use of ciphers and hieroglyphic writings.

Clemens observes, that these orders corresponded very exactly to those among the Hebrews: for in the schools of the prophets there were two classes, viz. the sons of the prophets, who were the scholars, and the doctors or masters, who were also called *perfecti*; and among the Levites, the novices or tyros, who had their quinquennial exercises, by way of preparation. Lastly, even among the proselytes there were two orders; *exoterici*, or proselytes of the gate; and *intrinseci* or *perfecti*, proselytes of the covenant. He adds, it is highly probable, that Pythagoras himself had been a proselyte of the gate, if not of the covenant. Gale endeavours to prove that Pythagoras borrowed his philosophy from that of the Jews; to this end producing the authorities of many of the fathers and ancient authors, and even pointing out the tracks and footsteps of Moses in several parts of Pythagoras's doctrine. But we believe the learned author was misled by the Christian Platonists.

The authority of Pythagoras among his pupils was so great, that it was even deemed a crime to dispute his word; and their arguments were considered as infallibly convincing, if they could enforce them by adding, that "the master said so;" an expression which afterwards became proverbial in *jurare in verba magistri*. This influence over his school was soon extended to the world, and even his pupils themselves divided the applause and approbation of the people with their master; and the rulers and legislators of all the principal towns of Greece, Sicily, and Italy, boasted of being the disciples of Pythagoras. To give more weight to his exhortations, as some writers mention, Pythagoras retired into a subterraneous cave, where his mother sent him intelligence of every thing which happened during his absence. After a certain number of months he again re-appeared on the earth with a grim and ghastly countenance, and declared in the assembly of the people that he was returned from hell. From similar exaggerations it has been asserted that he appeared at the Olympic games with a golden thigh, and that he could write in letters of blood whatever he pleased on a looking-glass; and that by setting it opposite to the moon, when full, all the characters which were on the glass became legible on the moon's disc. They also relate, that by some magical words he tamed a bear, stopped the flight of an eagle, and appeared on the same day and at the same instant in the cities of Crotona and Metapontum, &c.

At length his singular doctrines, and perhaps his strenuously asserting the rights of the people against their tyrannical governors, excited a spirit of jealousy, and raised a powerful party against him; which soon became so outrageous as to oblige him to fly for his life. His friends fled to Rhegium; and he himself, after being refused protection by the Locrians, fled to Metapontum, where he was obliged to take refuge in the temple of the muses, and where it is said he died of hunger about 497 years before Christ. Respecting the time, place, and manner of his death, however, there are various opinions, and many think it uncertain when, where, or in what manner, he ended his days. After his death his followers paid the same respect to him as was paid to the immortal gods; they erected statues in honour of him, converted his house at Crotona into a temple of Ceres, appealed to him as a deity, and swore by his name.

Pythagoras married Theano of Crotona, or, according to others, of Crete, by whom he had two sons, Telauges and Mnesarchus, who, after his death, took care of his school. He is said also to have had a daughter called *Damo*.

Whether he left any writings behind him is disputed. It seems probable, however, that he left none, and that such

ſuch as went under his name were written by ſome of his followers. The *golden verſes* which Hierocles illuſtrated with a commentary, have been aſcribed to Epicharmus or Empedocles, and contain a brief ſummary of his popular doctrines. From this circumſtance, and from the myſterious ſecrecy with which he taught, our information concerning his doctrine and philoſophy is very uncertain, and cannot always be depended on.

The purpoſe of philoſophy, according to the ſyſtem of Pythagoras, is to free the mind from incumbrances, and to raiſe it to the contemplation of immutable truth and the knowledge of divine and ſpiritual objects. To bring the mind to this ſtate of perfection is a work of ſome difficulty, and requires a variety of intermediate ſteps. Mathematical ſcience was with him the firſt ſtep to wiſdom, becauſe it inures the mind to contemplation, and takes a middle courſe between corporeal and incorporeal beings. The whole ſcience he divided into two parts, *numbers* and *magnitude*; and each of theſe he ſubdivided into two others, the former into *arithmetic* and *muſic*, and the latter into *magnitude at reſt and in motion*; the former of which comprehends *geometry*, and the latter *aſtronomy*. Arithmetic he conſidered as the nobleſt ſcience, and an acquaintance with numbers as the higheſt good. He conſidered numbers as the principles of every thing; and divided them into ſcientific and intelligible. Scientific number is the production of the powers involved in unity, and its return to the ſame; number is not infinite, but is the ſource of that infinite diviſibility into equal parts which is the property of all bodies. Intelligible numbers are thoſe which exiſted in the divine mind before all things. They are the model or archetype of the world, and the cauſe of the eſſence of beings. Of the Monad, Duad, Triad, Tetrad, and Decad, various explanations have been given by various authors; but nothing certain or important is known of them. In all probability, numbers were uſed by Pythagoras as ſymbolical repreſentations of the firſt principles and forms of nature, and eſpecially of thoſe eternal and immutable eſſences which Plato denominated ideas; and in this caſe the Monad was the ſimple root from which he conceived numbers to proceed, and as ſuch, analogous to the ſimple eſſence of deity; from whence, according to his ſyſtem, the various properties of nature proceed.

Muſic followed numbers, and was uſeful in raiſing the mind above the dominion of the paſſions. Pythagoras conſidered it as a ſcience to be reduced to mathematical principles and proportions, and is ſaid to have diſcovered the muſical chords from the circumſtance of ſeveral men ſucceſſively ſtriking with hammers a piece of heated iron upon an anvil. This ſtory Dr Burney * diſcredits; but allows, from the uniform teſtimony of writers ancient and modern, that he invented the *harmonical canon* or monochord, (ſee MONOCHORD.) The muſic of the ſpheres, of which every one has heard, was a moſt fanciful doctrine of Pythagoras. It was produced, he imagined, by the planets ſtriking on the ether through which in their motion they paſſed; and he conſidered their muſical proportions as exact, and their harmony perfect.

* Hiſtory Muſic, l. i. 441.

Pythagoras, as we have already ſeen, learned geometry in Egypt; but by inveſtigating many new theorems, and by digeſting its principles, he reduced it to a more regular ſcience. A geometrical point, which he defines to be a monad, or unity with poſition, he ſays correſponds to unity in arithmetic, a line to two, a ſuperficies to three, and a ſolid to four. He diſcovered ſeveral of the propoſitions of Euclid; and on diſcovering the 47th of book 1ſt, he is ſaid to have offered a hecatomb to the gods; but as he was averſe to animal ſacrifices, this aſſertion is ſurely falſe. His great progreſs in aſtronomical ſcience has been mentioned elſewhere. See ASTRONOMY, n° 11, 22; and PHILOSOPHY, n° 15, 16.

Wiſdom, according to Pythagoras, is converſant with thoſe objects which are naturally immutable, eternal, and incorruptible; and its end is to aſſimilate the human mind to the divine, and to qualify us to join the aſſembly of the gods. Active and moral philoſophy preſcribes rules and precepts for the conduct of life, and leads us to the practice of public and private virtue.—On theſe heads many of his precepts were excellent, and ſome of them were whimſical and uſeleſs. Theoretical philoſophy treats of nature and its origin, and is, according to Pythagoras, the higheſt object of ſtudy. It included all the profound myſteries which he taught, of which but little is now known. God he conſiders as the univerſal mind, diffuſed through all things, and the ſelf-moving principle of all things (αυτοματισμος των παντων), and of whom every human ſoul is a portion *. It is very probable, that he conceived of the Deity as a ſubtle fire, eternal, active, and intelligent; which is not inconſiſtent with the idea of incorporeality, as the ancients underſtood that term. This Deity was primarily combined with the chaotic maſs of paſſive matter, but he had the power of ſeparating himſelf, and ſince the ſeparation he has remained diſtinct. The learned Cudworth contends, that Pythagoras maintained a trinity of hypoſtaſes in the divine nature, ſimilar to the Platonic triad (ſee PLATONISM). We cannot ſay that his arguments appear to have much force; but we think the concluſion which he wiſhes to eſtabliſh extremely probable, as Plato certainly drew his doctrine from ſome of the countries which Pythagoras had viſited before him.

* Cicero de Seneƈt. § 21.

Subordinate to the Deity there were in the Pythagorean creed three orders of intelligences, gods, demons, and heroes, of different degrees of excellence and dignity. Theſe, together with the human ſoul, were conſidered as emanations from the Deity, the particles of ſubtle ether aſſuming a groſſer clothing the farther they receded from the fountain. Hierocles defines a hero to be a rational mind united with a luminous body. God himſelf was repreſented under the notion of monad, and the ſubordinate intelligences as numbers derived from and included in unity. Man is conſidered as conſiſting of an elementary nature and a divine or rational ſoul. His ſoul, a ſelf-moving principle, is compoſed of two parts; the rational, ſeated in the brain; and the irrational, including the paſſions, in the heart. In both theſe reſpects he participates with the brutes, whom the temperament of their body, &c. allows not to act rationally. The ſenſitive ſoul periſhes; the other aſſumes an ethereal vehicle, and paſſes to the regions of the dead, till ſent back to the earth to inhabit ſome other body, brutal or human. See METEMPSYCHOSIS. It was unqueſtionably this notion which led Pythagoras and his followers to deny themſelves the uſe of fleſh, and to be ſo peculiarly merciful to animals of every deſcription. Some authors, however, ſay, that fleſh and beans, the uſe of which he alſo forbad, were prohibited,

Pythagoras. because he supposed them to have been produced from the same putrified matter, from which, at the creation of the world, man was formed.

Of the symbols of Pythagoras little is known. They have been religiously concealed; and though they have awakened much curiosity, and occasioned many ingenious conjectures, they still appear to us dark and trifling. As a specimen we give the following: "Adore the sound of the whispering wind. Stir not the fire with a sword. Turn aside from an edged tool. Pass not over a balance. Setting out on a journey, turn not back, for the furies will return with you. Breed nothing that hath crooked talons. Receive not a swallow into your house. Look not in a mirror by the light of a candle. At a sacrifice pair not your nails. Eat not the heart or brain. Taste not that which hath fallen from the table. Break not bread. Sleep not at noon. When it thunders touch the earth. Pluck not a crown. Roast not that which has been boiled. Sail not on the ground. Plant not a palm. Breed a cock, but do not sacrifice it, for it is sacred to the sun and moon. Plant mallows in thy garden, but eat them not. Abstain from beans."

The following precepts are more important: "Discourse not of Pythagorean doctrines without light. Above all things govern your tongue. Engrave not the image of God in a ring. Quit not your station without the command of your general. Remember that the paths of virtue and of vice resemble the letter Y. To this symbol Persius refers†, when he says,

Et tibi quæ Samios diduxit litera ramos,
Surgentem dextro monstravit limite collem.

There has the Samian Y's instructive make
Pointed the road thy doubtful foot should take;
There warn'd thy raw and yet unpractis'd youth,
To tread the rising right-hand path of truth.

† Sat. III. 56.

The scantiness and uncertainty of our information respecting Pythagoras, renders a regular and complete account of his life and doctrines impossible. A modern author ‡ of profound erudition, pronounces him to have been *unquestionably* the wisest man that ever lived, if his masters the Egyptian priests must not be excepted. This is saying a great deal too much; but that he was one of the most distinguished philosophers of antiquity, or, as Cicero expresses it, *vir præstanti sapientia*, appears very evident; and his moral character has never been impeached. The mysterious air which he threw over his doctrines, and the apparent inanity of some of his symbols, have indeed subjected him to the charge of imposture, and perhaps the charge is not wholly groundless: but when we consider the age in which he lived, and the nature of the people with whom he had to deal, who would in all probability have resisted more open innovations, even this will not appear so blameable as at first sight we are apt to think it; and it is worthy of notice, that the worst stories of this kind have come down to us in a very questionable shape, and with much probability appear to be false.

‡ *Ancient Metaphysics.*

Pythagoreans || Python.

PYTHAGOREANS, a sect of ancient philosophers, so called from being the followers of Pythagoras. See the preceding article.

PYTHIA, the priestess of Apollo at Delphi, by whom he delivered oracles. She was so called from Pythius, a name of that god, which is said to have been given him on account of his victory over the serpent Python.

The Pythia was at first required to be a young girl, but in later times she was a woman of 50 years of age. The first and most famous Pythia was Phemonöe. Oracles were at first delivered by her in hexameter verse. All the pythias were to be pure virgins, and all of them delivered their oracles with great enthusiasm and violent agitations. See ORACLE and DELPHI.

PYTHIAN GAMES, in Grecian antiquity, sports instituted near Delphos in honour of Apollo, on account of his slaying the serpent Python. See APOLLO.—These games, at their first institution, were celebrated only once in nine years; but afterwards every fifth year, from the number of the Parnassian nymphs who came to congratulate Apollo, and to make him presents on his victory. The victor was crowned with garlands.

PYTHON, in fabulous history, a monstrous serpent, produced by the earth after Deucalion's deluge. Juno being exasperated at Latona, who was beloved by Jupiter, commanded this serpent to destroy her; but flying from the pursuit of the monster, she escaped to Delos, where she was delivered of Diana and Apollo; the latter of whom at length destroyed Python with his arrows, in memory of which victory the Pythian games were instituted. See APOLLO.

Q.

Q, or *q*, the 16th letter and 12th consonant of our alphabet; but is not to be found either in the Greek, old Latin, or Saxon alphabets; and indeed some would entirely exclude it, pretending that k ought to be used wherever this occurs. However, as it is formed in the voice in a different manner, it is undoubtedly a distinct letter: for, in expressing this sound, the cheeks are contracted, and the lips, particularly the under one, are put into a canular form, for the passage of the breath.

The q is never sounded alone, but in conjunction with u, as in *quality*, *question*, *quite*, *quote*, &c. and never ends any English word.

As a numeral, Q stands for 500; and with a dash over it, thus $\bar{Q}$, for 500,000.

Used as an abbreviature, *q* signifies *quantity*, or *quantum*.

Quab || Quadrant.

tum. Thus, among phyſicians, *q. pl.* is *quantum placet*, i. e. "as much as you pleaſe" of a thing; and *q. ſ.* is *quantum ſufficit*, i. e. "as much as is neceſſary." Q. E. D. among mathematicians, is *quod erat demonſtrandum*, i. e. "which was to be demonſtrated;" and Q. E. F. is *quod erat faciendum*, i. e. "which was to be done." Q. D. among grammarians, is *quaſi dictum*, i. e. "as if it were ſaid;" or, "as who ſhould ſay." In the notes of the ancients, Q ſtands for *Quintus*, or *Quintius*; Q. B. V. for *quod bene vertat*; Q. S. S. S. for *quæ ſupra ſcripta ſunt*; Q. M. for *Quintus Mutius*, or *quomodo*; Quint. for *Quintilius*; and Quæſ. for *quæſtor*.

QUAB, in ichthyology, the name of a Ruſſian fiſh, which is ſaid to be at firſt a tadpole, then a frog, and at laſt a fiſh. Dr Mounſey, who made many inquiries concerning theſe pretended changes, conſiders them all as fabulous. He had opportunity of ſeeing the fiſh itſelf, and found that they ſpawned like other fiſhes, and grew in ſize, without any appearances to juſtify the report. He adds, that they delight in very clear water, in rivers with ſandy or ſtony bottoms, and are never found in ſtanding lakes, or in rivers paſſing through marſhy or moſſy grounds, where frogs choose moſt to be.

QUABES, are a free people of Africa, inhabiting the ſouthern banks of the river Seſtos, and between that and Sierra Leona. They are under the protection of the emperor of Manow.

QUACHA, or QUAGGA. See EQUUS, n° 5.

QUACHILTO, in ornithology, is the name of a very beautiful Braſilian bird, called alſo *yacazintli*, and *porphyrio Americanus*. It is of a fine blackiſh purple colour, variegated with white; its beak is white while young, but becomes red as it grows older, and has a naked ſpace at its baſis, reſembling in ſome ſort the coot; its legs are of a yellowiſh green; it lives about the waters, and feeds on fiſh, yet is a very well taſted bird. It imitates the crowing of a common cock, and makes its muſic early in the morning.

Marg-rave's Hiſt. Braſil.

QUACK, among phyſicians, the ſame with empiric. See the article EMPIRIC.

QUADI, (Tacitus); a people of Germany, ſituated to the ſouth-eaſt of the mountains of Bohemia, on the banks of the Danube, and extending as far as the river Marus, or March, running by Moravia, which country they occupied.

QUADRAGESIMA, a denomination given to lent, from its conſiſting of 40 days. See LENT.

QUADRANGLE, in geometry, the ſame with a quadrilateral figure, or one conſiſting of four ſides and four angles.

QUADRANS, the quarter or fourth part of any thing, particularly the *as*, or pound.

QUADRANS, in Engliſh money, the fourth part of a penny. Before the reign of Edward I. the ſmalleſt coin was a *ſterling*, or penny, marked with a croſs; by the guidance of which a penny might be cut into halves for a halfpenny, or into quarters or four parts for farthings; till, to avoid the fraud of unequal cuttings, that king coined halfpence and farthings in diſtinct round pieces.

QUADRANT, in geometry, the arch of a circle, containing 90°, or the fourth part of the entire periphery.

Sometimes alſo the ſpace or area, included between this arch and two radii drawn from the centre to each extremity thereof, is called a *quadrant*, or, more properly, a *quadrantal ſpace*, as being a quarter of an entire circle. Quadrant.

QUADRANT, alſo denotes a mathematical inſtrument of great uſe in aſtronomy and navigation, for taking the altitudes of the ſun and ſtars, as alſo for taking angles in ſurveying, &c.

This inſtrument is variouſly contrived, and furniſhed with different apparatus, according to the various uſes it is intended for; but they all have this in common, that they conſiſt of a quarter of a circle, whoſe limb is divided into 90°. Some have a plummet ſuſpended from the centre, and are furniſhed with ſights to look through.

The principal and moſt uſeful quadrants are the common ſurveying quadrant, aſtronomical quadrant, Adams's quadrant, Cole's quadrant, Gunter's quadrant, Hadley's quadrant, horodictical quadrant, Sutton's or Collins's quadrant, and the ſinical quadrant, &c. Of each of which in order.

1. The common ſurveying quadrant, is made of braſs, wood, or any other ſolid ſubſtance; the limb of which is divided into 90°, and each of theſe farther divided into as many equal parts as the ſpace will allow, either diagonally or otherwiſe. On one of the ſemidiameters are fitted two moveable ſights; and to the centre is ſometimes alſo fixed a label, or moveable index, bearing two other ſights; but in lieu of theſe laſt ſights there is ſometimes fitted a teleſcope: alſo from the centre there is hung a thread with a plummet; and on the under ſide or face of the inſtrument is fitted a ball and ſocket, by means of which it may be put into any poſition. The general uſe of it is for taking angles in a vertical plane, comprehended under right lines going from the centre of the inſtrument, one of which is horizontal, and the other is directed to ſome viſible point. But beſides the parts already deſcribed, there is frequently added on the face, near the centre, a kind of compartment, called the *quadrat*, or *geometrical ſquare*. See QUADRAT.

This quadrant may be uſed in different ſituations: for obſerving heights or depths, its plane muſt be diſpoſed perpendicularly to the horizon; but to take horizontal diſtances, its plane is diſpoſed parallel thereto. Again, heights and diſtances may be taken two ways, viz. by means of the fixed ſights and plummet, or by the label: As to which, and the manner of meaſuring angles, ſee GEOMETRY, p. 674, &c.

2. The aſtronomical quadrant is a large one, uſually made of braſs, or wooden bars faced with iron plates; having its limb nicely divided, either diagonally or otherwiſe, into degrees, minutes, and ſeconds; and furniſhed with two teleſcopes, one fixed on the ſide of the quadrant, and the other moveable about the centre, by means of the ſcrew. There are alſo dented wheels which ſerve to direct the inſtrument to any object or phenomenon.—The uſe of this curious inſtrument, in taking obſervations of the ſun, planets, and fixed ſtars, is obvious; for being turned horizontally upon its axis, by means of the teleſcope, till the object is ſeen through the moveable teleſcope, then the degrees, &c. cut by the index give the altitude required. See ASTRONOMY, p. 587, &c.

Quadrant. Plate CCCXXVII.

3. Cole's quadrant is a very useful instrument invented by Mr Benjamin Cole. It consists of 6 parts, *viz.* the staff AB (fig. 1.); the quadrantal arch DE; three vanes A, B, C; and the vernier FG. The staff is a bar of wood about two feet long, an inch and a quarter broad, and of a sufficient thickness to prevent it from bending or warping. The quadrantal arch is also of wood; and is divided into degrees, and third-parts of a degree, to a radius of about nine inches; to its extremities are fitted two radii, which meet in the centre of the quadrant by a pin, round which it easily moves. The sight-vane A is a thin piece of brass, almost two inches in height and one broad, placed perpendicularly on the end of the staff A, by the help of two screws passing through its foot. Through the middle of this vane is drilled a small hole, through which the coincidence or meeting of the horizon and solar spot is to be viewed. The horizon vane B is about an inch broad, and two inches and a half high, having a slit cut thro' it of near an inch long and a quarter of an inch broad; this vane is fixed in the centre-pin of the instrument, in a perpendicular position, by the help of two screws passing through its foot, whereby its position with respect to the sight-vane is always the same, their angles of inclination being equal to 45 degrees. The shade-vane C is composed of two brass plates. The one, which serves as an arm, is about four inches and a half long, and three quarters of an inch broad, being pinned at one end to the upper limb of the quadrant by a screw, about which it has a small motion; the other end lies in the arch, and the lower edge of the arm is directed to the middle of the centre-pin; the other plate, which is properly the vane, is about two inches long, being fixed perpendicularly to the other plate, at about half an inch distance from that end next the arch; this vane may be used either by its shade or by the solar spot cast by a convex lens placed therein. And, because the wood-work is often apt to warp or twist, therefore this vane may be rectified by the help of a screw, so that the warping of the instrument may occasion no error in the observation, which is performed in the following manner: Set the line G on the vernier against a degree on the upper limb of the quadrant, and turn the screw on the backside of the limb forward or backward, till the hole in the sight-vane, the centre of the glass, and the sunk spot in the horizon-vane, lie in a right line.

To find the sun's altitude by this instrument: Turn your back to the sun, holding the instrument by the staff with your right hand, so that it be in a vertical plane passing through the sun; apply your eye to the sight-vane, looking through that and the horizon-vane till you see the horizon; with the left hand slide the quadrantal arch upwards, until the solar spot or shade, cast by the shade-vane, fall directly on the spot or slit in the horizon-vane; then will that part of the quadrantal arch, which is raised above G or S (according as the observation respected either the solar spot or shade) show the altitude of the sun at that time. But if the meridian altitude be required, the observation must be continued; and as the sun approaches the meridian, the sea will appear through the horizon-vane, and then is the observation finished; and the degrees and minutes, counted as before, will give the sun's meridian altitude: or the degrees counted from the lower limb upwards will give the zenith-distance.

4. Adams's quadrant differs only from Cole's quadrant in having an horizontal vane, with the upper part of the limb lengthened; so that the glass, which casts the solar spot on the horizon-vane, is at the same distance from the horizon-vane as the sight-vane at the end of the index.

5. Gunter's quadrant, so called from its inventor Edmund Gunter, besides the usual apparatus of other quadrants, has a stereographical projection of the sphere on the plane of the equinoctial. It has also a kalendar of the months, next to the divisions of the limb.

Use of Gunter's quadrant. 1. To find the sun's meridian altitude for any given day, or the day of the month for any given meridian altitude. Lay the thread to the day of the month in the scale next the limb; and the degree it cuts in the limb is the sun's meridian altitude. Thus the thread, being laid on the 15th of May, cuts 59° 30′, the altitude sought; and, contrarily, the thread, being set to the meridian altitude, shows the day of the month. 2. To find the hour of the day. Having put the bead, which slides on the thread, to the sun's place in the ecliptic, observe the sun's altitude by the quadrant; then, if the thread be laid over the same in the limb, the bead will fall upon the hour required. Thus suppose on the 10th of April, the sun being then in the beginning of Taurus, I observe the sun's altitude by the quadrant to be 36°; I place the bead to the beginning of Taurus in the ecliptic, and lay the thread over 36° of the limb; and find the bead to fall on the hour-line marked 3 and 9; accordingly the hour is either 9 in the morning or 3 in the afternoon. Again, laying the bead on the hour given, having first rectified or put it to the sun's place, the degree cut by the thread on the limb gives the altitude. Note, the bead may be rectified otherwise, by bringing the thread to the day of the month, and the bead to the hour-line of 12. 3. To find the sun's declination from his place given, and contrariwise. Set the bead to the sun's place in the ecliptic, move the thread to the line of declination, and the bead will cut the degree of declination required. Contrarily, the bead being adjusted to a given declination, and the thread moved to the ecliptic, the bead will cut the sun's place. 4. The sun's place being given, to find his right ascension, or contrarily. Lay the thread on the sun's place in the ecliptic, and the degree it cuts on the limb is the right ascension sought. Contrarily, laying the thread on the right ascension, it cuts the sun's place in the ecliptic. 5. The sun's altitude being given, to find his azimuth, and contrariwise. Rectify the bead for the time, as in the second article, and observe the sun's altitude: bring the thread to the complement of that altitude; thus the bead will give the azimuth sought, among the azimuth lines. 6. To find the hour of the night from some of the five stars laid down on the quadrant. (1.) Put the bead to the star you would observe, and find how many hours it is off the meridian, by article 2. (2.) Then, from the right ascension of the star, subtract the sun's right ascension converted into hours, and mark the difference; which difference, added to the observed hour of the star from the meridian,

dian, shows how many hours the sun is gone from the meridian, which is the hour of the night. Suppose on the 15th of May the sun is in the 4th degree of Gemini, I set the bead to Arcturus; and, observing his altitude, find him to be in the west about 50° high, and the bead to fall on the hour-line of 2 in the afternoon; then will the hour be 11 hours 50 minutes past noon, or 10 minutes short of midnight: for 62°, the sun's right ascension, converted into time, makes 4 hours 8 minutes; which, subtracted from 13 hours 58 minutes, the right ascension of Arcturus, the remainder will be 9 hours 50 minutes; which added to 2 hours, the observed distance of Arcturus from the meridian, shows the hour of the night to be 11 hours 50 minutes.

The mural quadrant has already been described under the article ASTRONOMY, n° 497. It is a most important instrument, and has of late been much improved by Mr Ramsden, who has distinguished himself by the accuracy of his divisions, and by the manner in which he finishes the planes by working them in a vertical position. He places the plumb-line behind the instrument, that there may be no necessity for removing it when we take an observation near the zenith. His manner of suspending the glass, and that of throwing light on the object-glass and on the divisions at the same time, are new, and improvements that deserve to be noticed.—Those of eight feet, which he has made for the observatories of Padua and Vilna, have been examined by Dr Maskelyne; and the greatest error does not exceed two seconds and a half. That of the same size for the observatory of Milan is in a very advanced state. The mural quadrant, of six feet, at Blenheim, is a most admirable instrument. It is fixed to four pillars, which turn on two pivots, so that it may be put to the north and to the south in one minute. It was for this instrument Mr Ramsden invented a method of rectifying the arc of 90 degrees, on which an able astronomer had started some difficulties; but by means of an horizontal line and a plumb-line, forming a kind of cross, without touching the circle, he showed him that there was not an error of a single second in the 90 degrees; and that the difference was occasioned by a mural quadrant of Bird, in which the arc of 90 degrees was too great by several seconds, and which had never been rectified by so nice a method as that of Mr Ramsden.

But the quadrant is not the instrument which stands highest in Mr Ramsdem's opinion; it is the complete circle: and he has demonstrated to M. de la Lande, that the former must be laid aside, if we would arrive at the utmost exactness of which an observation is capable. His principle reasons are: 1. The least variation in the centre is perceived by the two diametrically opposite points. 2. The circle being worked on the turn, the surface is always of the greatest accuracy, which it is impossible to obtain in the quadrant. 3. We may always have two measures of the same arc, which will serve for the verification of each other. 4. The first point of the division may be verified every day with the utmost facility. 5. The dilatation of the metal is uniform, and cannot produce any error. 6. This instrument is a meridian glass at the same time. 7. It also becomes a moveable azimuth circle by adding an horizontal circle beneath its axis, and then gives the refractions independent of the mensuration of time.

6. Hadley's quadrant is an instrument of vast utility both in navigation and practical astronomy. It derives its name from Mr Hadley, who first published an account of it, though the first thought originated with the celebrated Dr Hooke, and was completed by Sir Isaac Newton (see ASTRONOMY, n° 32. and also n° 17. and 22.) The utility of this quadrant arises from the accuracy and precision with which it enables us to determine the latitude and longitude; and to it is navigation much indebted for the very great and rapid advances it has made of late years. It is easy to manage, and of extensive use, requiring no peculiar steadiness of hand, nor any such fixed basis as is necessary to other astronomical instruments. It is used as an instrument for taking angles in maritime surveying, and with equal facility at the mast head as upon the deck, by which its sphere of observation is much extended; for supposing many islands to be visible from the mast head, and only one from deck, no useful observation can be made by any other instrument. But by this, angles may be taken at the mast head from the one visible object with great exactness; and further, taking angles from heights, as hills, or a ship mast's head, is almost the only way of exactly describing the figure and extent of shoals.

It has been objected to the use of this instrument for surveying, that it does not measure the horizontal angles, by which alone a plan can be laid down. This objection, however true in theory, may be reduced in practice by a little caution; and Mr Adams has given very good directions for doing so.

Notwithstanding, however, the manifest superiority of this instrument over those that were in use at the time of its publication, it was many years before the sailors could be persuaded to adopt it, and lay aside their imperfect and inaccurate instruments; so great is the difficulty to remove prejudice, and emancipate the mind from the slavery of opinion. No instrument has undergone, since the original invention, more changes than the quadrant of Hadley; of the various alterations, many had no better foundation than the caprice of the makers, who by these attempts have often rendered the instrument more complicated in construction, and more difficult in use, than it was in its original state.

It is an essential property of this instrument, derived from the laws of reflection, that half degrees on the arch answer to whole ones in the angles measured: hence an octant, or the eighth part of a circle, or 45 degrees on the arch, serves to measure 90 degrees; and sextants will measure an angular distance of 120 degrees, tho' the arch of the instrument is no more than 60 degrees. It is from this property that foreigners term that instrument an *octant*, which we usually call a *quadrant*, and which in effect it is. This property reduces indeed considerably the bulk of the instrument: but at the same time it calls for the utmost accuracy in the divisions, as every error on the arch is doubled in the observation.

Another essential, and indeed an invaluable, property of this instrument, whereby it is rendered peculiarly advantageous in marine observations, is, that it is not liable

[Pages 727 and 728, Vol. XV. Part II. to be cancelled, and this leaf to be put in their place.]

Quadrant. to be disturbed by the ship's motion; for provided the mariner can see distinctly the two objects in the field of his instrument, no motion nor vacillation of the ship will injure his observation.

Thirdly, the errors to which it is liable are easily discovered and readily rectified, while the application and use of it is facile and plain.

To find whether the two surfaces of any one of the reflecting glasses be parallel, apply your eye at one end of it, and observe the image of some object reflected very obliquely from it; if that image appears single, and well-defined about the edges, it is a proof that the surfaces are parallel: on the contrary, if the edge of the reflected images appear misted, as if it threw a shadow from it, or separated like two edges, it is a proof that the two surfaces of the glass are inclined to each other: if the image in the speculum, particularly if that image be the sun, be viewed through a small telescope, the examination will be more perfect.

To find whether the surface of a reflecting glass be plane. Choose two distant objects, nearly on a level with each other; hold the instrument in an horizontal position, view the left hand object directly through the transparent part of the horizon glass, and move the index till the reflected image of the other is seen below it in the silvered part; make the two images unite just at the line of separation, then turn the instrument round slowly on its own plane, so as to make the united images move along the line of separation of the horizon-glass. If the images continue united without receding from each other, or varying their respective position, the reflecting surface is a good plane.

To find if the two surfaces of a red or darkening glass are parallel and perfectly plane. This must be done by means of the sun when it is near the meridian, in the following manner: hold the sextant vertically, and direct the sight to some object in the horizon, or between you and the sky, under the sun; turn down the red glass and move the index till the reflected image of the sun is in contact with the object seen directly: fix then the index, and turn the red glass round in its square frame; view the sun's image and object immediately, and if the sun's image is neither raised nor depressed, but continues in contact with the object below, as before, then the surfaces of the darkening glass are true.

For a more particular description of Hadley's quadrant, and the mode of using it, see Navigation, Book II. Chap. I.

This instrument has undergone several improvements since its first invention, and among these improvers must be ranked Mr Ramsden. He found that the essential parts of the quadrant had not a sufficient degree of solidity; the friction at the centre was too great, and in general the alidada might be moved several minutes without any change in the position of the mirror; the divisions were commonly very inaccurate, and Mr Ramsden found that Abbé de la Caille did not exceed the truth in estimating at five minutes the error to which an observer was liable in taking the distance between the moon and a star; an error capable of producing a mistake of 50 leagues in the longitude. On this account Mr Ramsden changed the principle of construction of the centre, and made the instrument in such a manner as never to give an error of more than half a minute; and he has now brought them to such a degree of perfection as to warrant it not more than six seconds in a quadrant of fifteen inches. Since the time of having improved them, Mr Ramsden has constructed an immense number; and in several which have been carried to the East Indies and America, the deficiency has been found no greater at their return than it had been determined by examinations before their being taken out. Mr Ramsden has made them from 15 inches to an inch and a half, in the latter of which the minutes are easily distinguishable; but he prefers for general use those of 10 inches, as being more easily handled than the greater, and at the same time capable of equal accuracy. See Sextant.

A great improvement was also made in the construction of this quadrant by Mr Peter Dollond, famous for his invention of achromatic telescopes. The glasses of the quadrants should be perfect planes, and have their surfaces perfectly parallel to one another. By a practice of several years, Mr Dollond found out methods of grinding them of this form to great exactness; but the advantage which should have arisen from the goodness of the glasses was often defeated by the index-glass being bent by the frame which contains it. To prevent this, Mr Dollond contrived the frame so that the glass lies on three points, and the part that presses on the front of the glass has also three points opposite to the former. These points are made to confine the glass by three screws at the back, acting directly opposite to the points between which the glass is placed. The principal improvements, however, are in the methods of adjusting the glasses, particularly for the back-observation. The method formerly practised for adjusting that part of the instrument by means of the opposite horizons at sea, was attended with so many difficulties that it was scarce ever used: for so little dependence could be placed on the observations taken this way, that the best Hadley's sextants made for the purpose of observing the distances of the moon from the sun or fixed stars have been always made without the horizon-glass for the back-observation; for want of which, many valuable observations of the sun and moon have been lost, when their distance exceeded 120 degrees. To make the adjustment of the back-observation easy and exact, he applied an index to the back horizon-glass, by which it may be moved in a parallel position to the index-glass, in order to give it the two adjustments in the same manner as the fore-horizon-glass is adjusted. Then, by moving the index to which the back-horizon-glass is fixed exactly 90 degrees (which is known by the divisions made for that purpose), the glass will thereby be set at right angles to the index-glass, and will be properly adjusted for use; and the observations may be made with the same accuracy by this as by the fore-observation. To adjust the horizon-glasses in the perpendicular position to the plane of the instrument, he contrived to move each of them by a single screw, which goes through the frame of the quadrant, and is turned by means of a milled head at the back; which may be done by the observer while he is looking at the object. To these improvements also he

he added a method invented by Mr Maſkelyne, of placing darkening-glaſſes behind the horizon-glaſſes. Theſe, which ſerve for darkening the object ſeen by direct viſion, in adjuſting the inſtrument by the ſun or moon, he placed in ſuch a manner as to be turned behind the fore horizon-glaſs, or behind the back horizon-glaſs: there are three of theſe glaſſes of different degrees of darkneſs.

We have been the more particular in our deſcription and uſe of Hadley's quadrant, as it is undoubtedly the beſt hitherto invented.

7. Horodictical quadrant, a pretty commodious inſtrument, ſo called from its uſe in telling the hour of the day.—Its conſtruction is this: From the centre of the quadrant, C, fig. 3. whoſe limb AB is divided into 90°, deſcribe ſeven concentric circles at intervals at pleaſure; and to theſe add the ſigns of the zodiac, in the order repreſented in the figure. Then applying a ruler to the centre C and the limb AB, mark upon the ſeveral parallels the degrees correſponding to the altitude of the ſun when therein, for the given hours; connect the points belonging to the ſame hour with a curve line, to which add the number of the hour. To the radius CA fit a couple of ſights, and to the centre of the quadrant C tie a thread with a plummet, and upon the thread a bead to ſlide. If now the thread be brought to the parallel wherein the ſun is, and the quadrant directed to the ſun, till a viſual ray paſs through the ſights, the bead will ſhow the hour; for the plummet, in this ſituation, cuts all the parallels in the degrees correſponding to the ſun's altitude. Since the bead is in the parallel which the ſun deſcribes, and through the degrees of altitude to which the ſun is elevated every hour there paſs hour-lines, the bead muſt ſhow the preſent hour. Some repreſent the hour-lines by arches of circles, or even by ſtraight lines, and that without any ſenſible error.

Plate CCCXXVII.

8. Sutton's or Collins's quadrant (fig. 4.) is a ſtereographic projection of one quarter of the ſphere between the tropics, upon the plane of the ecliptic, the eye being in its north-pole: it is fitted to the latitude of London. The lines running from the right hand to the left are parallels of altitude; and thoſe croſſing them are azimuths. The leſſer of the two circles, bounding the projection, is one fourth of the tropic of Capricorn; the greater is one fourth of that of Cancer. The two ecliptics are drawn from a point on the left edge of the quadrant, with the characters of the ſigns upon them; and the two horizons are drawn from the ſame point. The limb is divided both into degrees and time; and, by having the ſun's altitude, the hour of the day may be found here to a minute. The quadrantal arches next the centre contain the kalendar of months; and under them, in another arch, is the ſun's declination. On the projection are placed ſeveral of the moſt noted fixed ſtars between the tropics; and the next below the projection is the quadrant and line of ſhadows.—To find the time of the ſun's riſing or ſetting, his amplitude, his azimuth, hour of the day, &c. by this quadrant: lay the thread over the day and the month, and bring the bead to the proper ecliptic, either of ſummer or winter, according to the ſeaſon, which is called *rectifying*; then, moving the thread, bring the bead to the horizon, in which caſe the thread will cut the limb in the time of the ſun's riſing or ſetting before or after ſix; and at the ſame time the bead will cut the horizon in the degrees of the ſun's amplitude.—Again, obſerving the ſun's altitude with the quadrant, and ſuppoſing it found 45° on the fifth of May, lay the thread over the fifth of May, bring the bead to the ſummer ecliptic, and carry it to the parallel of altitude 45°; in which caſe the thread will cut the limb at 55° 15′, and the hour will be ſeen among the hour-lines to be either 41′ paſt nine in the morning, or 19′ paſt two in the afternoon.—Laſtly, the bead among the azimuths ſhows the ſun's diſtance from the ſouth 50° 41′. But note, that if the ſun's altitude be leſs than what it is at ſix o'clock, the operation muſt be performed among thoſe parallels above the upper horizon; the bead being rectified to the winter ecliptic.

9. Sinical quadrant (fig. 5.) conſiſts of ſeveral concentric quadrantal arches, divided into eight equal parts by radii, with parallel right lines croſſing each other at right angles. Now any one of the arches, as BC, may repreſent a quadrant of any great circle of the ſphere, but is chiefly uſed for the horizon or meridian. If then BC be taken for a quadrant of the horizon, either of the ſides, as AB, may repreſent the meridian; and the other ſide, AC, will repreſent a parallel, or line of eaſt and weſt: and all the other lines, parallel to AB, will be alſo meridians; and all thoſe parallel to AC, eaſt and weſt lines, or parallels.—Again, the eight ſpaces into which the arches are divided by the radii, repreſent the eight points of the compaſs in a quarter of the horizon; each containing 11° 15′. The arch BC is likewiſe divided into 90°, and each degree ſubdivided into 12′, diagonal-wiſe. To the centre is fixed a thread, which, being laid over any degree of the quadrant, ſerves to divide the horizon.

If the ſinical quadrant be taken for a fourth part of the meridian, one ſide thereof, AB, may be taken for the common radius of the meridian and equator; and then the other, AC, will be half the axis of the world. The degrees of the circumference, BC, will repreſent degrees of latitude; and the parallels to the ſide AB, aſſumed from every point of latitude to the axis AC, will be radii of the parallels of latitude, as likewiſe the ſine complement of thoſe latitudes.

Suppoſe, then, it be required to find the degrees of longitude contained in 83 of the leſſer leagues in the parallel of 48°; lay the thread over 48° of latitude on the circumference, and count thence the 83 leagues on AB, beginning at A; this will terminate in H, allowing every ſmall interval four leagues. Then tracing out the parallel HE, from the point H to the thread; the part AE of the thread ſhows that 125 greater or equinoctial leagues make 6° 15′; and therefore that the 83 leſſer leagues AH, which make the difference of longitude of the courſe, and are equal to the radius of the parallel HE, make 6° 15′ of the ſaid parallel.

If the ſhip ſails an oblique courſe, ſuch courſe, beſides the north and ſouth greater leagues, gives leſſer leagues eaſterly and weſterly, to be reduced to degrees of longitude of the equator. But theſe leagues being made neither on the parallel of departure, nor on that of arrival, but in all the intermediate ones, we muſt find a mean proportional parallel between them. To find this, we have on the inſtrument a ſcale of croſs latitudes. Suppoſe then it were required to find a mean

mean parallel between the parallels of 40° and 60°; with your compasses take the middle between the 40th and 60th degree on this scale: the middle point will terminate against the 51st degree, which is the mean parallel required.

The principal use of the sinical quadrant is to form triangles upon, similar to those made by a ship's way with the meridians and parallels; the sides of which triangles are measured by the equal intervals between the concentric quadrants and the lines N and S, E and W: and every fifth line and arch is made deeper than the rest. Now, suppose a ship to have sailed 150 leagues north-east, one fourth north, which is the third point, and makes an angle of 33° 44′ with the north part of the meridian: here are given the course and distance sailed, by which a triangle may be formed on the instrument similar to that made by the ship's course; and hence the unknown parts of the triangle may be found. Thus, supposing the centre A to represent the place of departure; count, by means of the concentric circles along the point the ship sailed on, viz. AD, 150 leagues: then in the triangle AED, similar to that of the ship's course, find AE = difference of latitude, and DE = difference of longitude, which must be reduced according to the parallel of latitude come to.

10. Gunner's quadrant (fig. 6.), sometimes called *gunner's square*, is that used for elevating and pointing cannon, mortars, &c. and consists of two branches either of brass or wood, between which is a quadrantal arch divided into 90 degrees, beginning from the shorter branch, and furnished with a thread and plummet, as represented in the figure.——The use of the gunner's quadrant is extremely easy; for if the longest branch be placed in the mouth of the piece, and it be elevated till the plummet cut the degree necessary to hit a proposed object, the thing is done. Sometimes on one of the surfaces of the long branch are noted the division of diameters and weights of iron bullets, as also the bores of pieces.

Quadrant of Altitude, is an appendage of the artificial globe, consisting of a lamina, or slip of brass, the length of a quadrant of one of the great circles of the globe, and graduated. At the end, where the division terminates, is a nut rivetted on, and furnished with a screw, by means whereof the instrument is fitted on the meridian, and moveable round upon the rivet to all points of the horizon.——Its use is to serve as a scale in measuring of altitudes, amplitudes, azimuths, &c. See Astronomy, n° 379, &c.

QUADRANTAL, in antiquity, the name of a vessel in use among the Romans for the measuring of liquids. It was at first called *amphora*; and afterwards *quadrantal*, from its form, which was square every way like a die. Its capacity was 80 libræ, or pounds of water, which made 48 sextaries, two urnæ, or eight congii.

QUADRAT, a mathematical instrument, called also a *Geometrical Square*, and *Line of Shadows*: it is frequently an additional member on the face of the common quadrant, as also on those of Gunter's and Sutton's quadrants. See Geometry, p. 672. and Plate CCXVII. fig. 1—5.

Quadrat, in printing, a piece of metal used to fill up the void spaces between words, &c. There are quadrats of different sizes; as m-quadrats, n-quadrats, &c. which are respectively of the dimensions of these letters, only lower, that they may not receive the ink.

QUADRATIC equations, in algebra, those wherein the unknown quantity is of two dimensions, or raised to the second power. See Algebra.

QUADRATRIX, in geometry, a mechanical line, by means whereof we can find right lines equal to the circumference of circles, or other curves, and their several parts.

QUADRATURE, in geometry, denotes the squaring, or reducing a figure to a square. Thus, the finding of a square, which shall contain just as much surface or area as a circle, an ellipsis, a triangle, &c. is the quadrature of a circle, ellipsis, &c. The quadrature, especially among the ancient mathematicians, was a great postulatum. The quadrature of rectilineal figures is easily found, for it is merely the finding their areas or surfaces *i. e.* their squares; for the squares of equal areas are easily found by only extracting the roots of the areas thus found. See Geometry, Part II. chap. 3. The quadrature of curvilinear spaces is of more difficult investigation; and in this respect extremely little was done by the ancients, except the finding the quadrature of the parabola by Archimedes. In 1657, Sir Paul Neil, Lord Brouncker, and Sir Christopher Wren, geometrically demonstrated the equality of some curvilinear spaces to rectilinear spaces; and soon after the like was proved both at home and abroad of other curves, and it was afterwards brought under an analytical calculus; the first specimen of which was given to the public in 1688 by Mercator, in a demonstration of Lord Brouncker's quadrature of the hyperbola, by Dr Wallis's reduction of a fraction into an infinite series by division. Sir Isaac Newton, however, had before discovered a method of attaining the quantity of all quadruple curves analytically by his fluxions before 1668. It is disputed between Sir Christopher Wren and Mr Huygens which of them first discovered the quadrature of any determinate cycloidal space. Mr Leibnitz afterwards found that of another space; and in 1669 Bernoulli discovered the quadrature of an infinity of cycloidal spaces both segments and sectors, &c. See Geometry, Part II. chap. 3. prop. 33.; and Fluxions, p. 314.

Quadrature, in astronomy, that aspect of the moon when she is 90° distant from the sun; or when she is in a middle point of her orbit, between the points of conjunction and opposition, namely, in the first and third quarters. See Astronomy, n° 320, &c.

QUADRATUS, in anatomy, a name given to several muscles on account of their square figure. See Anatomy, *Table of the Muscles*.

QUADREL, in building, a kind of artificial stone, so called from its being perfectly square. The quadrels are made of a chalky earth, &c. and dried in the shade for two years. These were formerly in great request among the Italian architects.

QUADRIGA, in antiquity, a car or chariot drawn by four horses. On the reverses of medals, we frequently see the emperor or Victory in a quadriga, holding the reins of the horses; whence these coins are, among the curious, called *nummi quadrigati*, and *victoriati*.

Quadrilateral. Quadrille.

QUADRILATERAL, in geometry, a figure whose perimeter consists of four sides and four angles; whence it is also called a *quadrangular figure*.

QUADRILLE, a little troop or company of cavaliers, pompously dressed, and mounted for the performance of carousals, justs, tournaments, runnings at the ring, and other gallant divertisements.

QUADRILLE, a game played by four persons, with 40 cards; which are the remains of a pack, after the four tens, nines, and eights are discarded; these are dealt three and three, and one round four, to the right hand player; and the trump is made by him that plays with or without calling, by naming spades, clubs, diamonds, or hearts, and the suit named is trumps. If the person who names the trump should mistake, and say spades instead of clubs, or if he name two suits, the first named is the trump.

In this game the order of the cards, according to their natural value, is as follows: of hearts and diamonds, *king, queen, knave, ace, deuce, three, four, five, six, seven;* in all 10; of spades and clubs, *king, queen, knave, seven, six, five, four, three, deuce;* in all 9. The reason why the ace of spades and ace of clubs are not mentioned, is, because they are always trumps, in whatever suit that is played. The ace of spades being always the first, and the ace of clubs the third trump, for the cards ranked according to their value when *trumps* stand in the following order.

Hearts and diamonds SPADILL, or the *ace of spades;* MANILL, the *seventh* of the two *red suits;* BASTO, the *ace of clubs;* PONTO, the *ace of hearts* and *diamonds; king, queen, knave, deuce, three, four, five, six;* in all 12. Spades and clubs, SPADILL the ace of spades, MANILL the *deuce* of spades and clubs, BASTO the ace of clubs; *king, queen, knave, seven, six, five, four, three;* in all 11. It is here to be observed, that the card which is *manill* and the second trump, is always the lowest in its suit when not trumps; and that the ace of hearts or diamonds, which when trump is above the king, is below the knave when not trump.

There are three matadores; spadill, manill, and basto; the privilege of which is, that when the player has no other trumps but them, and trumps are led, he is not obliged to play them, but may play what card he thinks proper, provided, however, that the trump led is of an inferior rank; but if spadill should be led, he that has manill or basto only, is obliged to play it; it is the same of manill basto, with respect to the superior matadore always forcing the inferior. Though there are properly but three matadores, nevertheless, all those trumps which follow the three first without interruption, are likewise called matadores; but the three first only enjoy the privilege above mentioned.

Each person is to play as he judges most convenient for his own game. He is not to encourage his friend to play; but each person ought to know what to do when it is his turn to play. The stakes consist of seven equal mils or *contrats*, as they are sometimes called, comprising the ten counters and fishes, which are given to each player. A mil is equal to ten fish, and each fish to ten counters: the value of the fish is according to the players agreement, as also the number of tours, which are generally fixed at ten, and marked by turning the corners of a card.

If the cards should happen not to be dealt right, or that there should be two cards of the same sort, as two deuces of spades, for example, there must be a new deal; provided it is discovered before the cards are all played. The cards must likewise be dealt over again in case a card is turned in dealing, as it might be of prejudice to him who should have it; and of course if there should be several cards turned. There is no penalty for dealing wrong, he who does so must only deal again.

When each player has got his ten cards, he that is on the right hand of the dealer, after examining his game, and finding his hand fit to play, asks if they play; or if he has not a good hand, he passes, and so the second, third, and fourth. All the four may pass; but he that has spadill, after having shown or named it, is obliged to play by calling a king. Whether the deal is played in this manner, or that one of the players has asked leave, nobody choosing to play without calling, the eldest hand must begin the play, first naming his suit, and the king which he calls; he who wins the trick plays another card, and so of the rest till the game is finished. The tricks then are counted; and if the ombre, that is, he who stands the game, has, together with him who is the king called, six tricks, they have won and are paid the game, the consolation, and the matadores, if they have them, and divide what is upon the game, and the beasts if there are any. But if they make only five tricks, it is a remise, and they are beasted, what goes upon the game, paying to the other players the consolation and the matadores. If the tricks are equally divided betwixt them, they are likewise beasted; and if they make only four tricks between them, it is a remise; if they make less they lose codill (A), and in that case they pay to their adversaries what they should have received if they had won; that is, the game, the consolation, and the matadores, if they have them, and are beasted what is upon the game: they who win codill, divide the stakes. The beast, and every thing else that is paid, is paid equally betwixt the two losers; one half by him that calls, and the other half by him that is called, as well in case of codill as a remise; unless the ombre does not make three tricks, in which case he that is called is not only exempted from paying half the beast, but also the game, the consolation, and the matadores if there are any, which the ombre in that case pays alone; and as well in case of a codill as a remise. This is done in order to oblige players not to play games that are unreasonable. There is, nevertheless, one case in which if the ombre makes only one trick, he is not beasted alone, and that is, when not having a good hand he passes, and all the other players have passed likewise; he having spadill is obliged to play. Here it would be unjust to oblige him to make three or four tricks; in this case, therefore, he that is called

(A) Codill is when those who defend the pool make more tricks than they who stand the game; which is called *winning the codill*.

Quadrille. called pays one half of the lofings. For which reafon he that has fpadill with a bad hand, fhould pafs, that if he is afterwards obliged to play by calling a king (which is called *forced fpadill*), he may not be beafted alone. He that has once paffed cannot be admitted to play; and he that has afked leave cannot refufe to play, unlefs any one fhould offer to play without calling.

He that has four kings, may call a queen to one of his kings, except that which is trump. He that wants one or more kings, may call one of thofe kings; but in that cafe, he muft make fix tricks alone, and confequently he wins or lofes alone. The king of that fuit in which he plays cannot be called. No one fhould play out of his turn, although he is not beafted for fo doing. If he who is not the eldeft hand has the king called, and plays fpadill, manill, or bafto, or even the king called in order to fhow that he is the friend, having other kings that he fears the ombre fhould trump, he is not to be allowed to go for the vole; he is even beafted, if it appears to be done with that intent. It is not permitted to fhow a hand though codill may already be won; that it may be feen whether the ombre is beafted alone. If the ombre or his friend fhows their cards before they have made fix tricks, thinking that they have made them, and there appears a poffibility of preventing their making them, the other players can oblige them to play their cards as they think proper.

A player need only name his fuit when he plays, without calling a king. He who plays without calling muft make fix tricks alone to win; for all the other players are united againft him, and they are to do what they can to prevent his winning. He who plays without calling, is admitted to play in preference to him who would play with calling; however, if he that has afked leave will play without calling, he has the preference of the other who would force him. Thefe are the two methods of play without calling that are called forced.

As he who plays without calling does not divide the winnings with any perfon, he confequently, when he lofes, pays all by himfelf; if he lofes by remife he is beafted, and pays each of the other players the confolation, the *fans appeller* (which is commonly, but improperly, called the *fans prendre*), and the matadores if there are any; if he lofes codill he is likewife beafted, and pays to each player what he would have received from each if he had win. They who win codill divide what there is; and if there are any counters remaining, they belong to him of the three who fhall have fpadill or the higheft trump the next deal. It is the fame with regard to him who calls one of his own kings, he wins alone or lofes alone as in the other cafe, except the fans appeller, which he does not pay if he lofes, or receive if he wins, although he plays alone.

If he plays fans appeller, though he may have a fure game, he is obliged to name his fuit; which if he neglects to do, and fhows his cards, and fays "I play fans appeller;" in that cafe either of the other players can oblige him to play in what fuit he pleafes, although he fhould not have one trump in that fuit.

He who has afked leave is not permitted to play fans appeller, unlefs he is forced; in which cafe, as was faid before, he has the preference of the other that forces him.

A player is not obliged to trump when he has none of the fuit led, nor play a higher card in that fuit if he has it, being at his option although he is the laft player, and the trick fhould belong to the ombre; but he is obliged to play in the fuit led if he can, otherwife he renounces. If he feparates a card from his game and fhows it, he is obliged to play it, if by not doing it the game may be prejudiced, or if it can give any intelligence to his friend; but efpecially if it fhould be a matadore.—He that plays fans appeller, or by calling himfelf, is not fubject to this law. He may turn the tricks made by the other players, and count what has been played as often as it is his turn to play, but not otherwife. If inftead of turning a player's tricks, he turns and fees his game, or fhows it to the other players, he is beafted, together with him whofe cards he turned; and each of them muft pay one half of the beaft.

If any one renounces, he is beafted as often as he has renounced and it is detected; but a renounce is not made till the trick is turned. If the renounce is difcoverd before the deal is finifhed, and has been detrimental to the game, the cards muft be taken up again, and the game replayed from that trick where the renounce was made; but if the cards are all played, the beaft is ftill made, and the cards muft not be replayed; except there fhould be feveral renounces in the fame deal: then they are to be played again, unlefs the cards fhould be mixed. If feveral beafts are made in the fame deal, they all go together, unlefs it is otherwife agreed at the beginning of the party; and when there are feveral beafts, the greateft always goes firft.

A great advantage accrues from being eldeft hand at quadrille, which often renders it very difagreeable to the reft of the players, being obliged to pafs with a good hand unlefs they choofe to play alone; and when it happens that the eldeft hand having afked leave, the fecond player has three matadores, feveral trumps in back, and all fmall cards, he cannot then even play alone; and having no chance of being called, he muft pafs with this good hand. On account of which, this method has been thought expedient to remedy this defect of the game; each player having an opportunity of availing himfelf of the goodnefs of his game, by adding to the ufual method of playing the game that of the mediateur, and the favourite fuit.

The firft thing to be obferved is that of drawing for places, which is done in this manner: One of the players takes four cards; a king, a queen, a knave, and an ace; each player draws one of thefe cards; and commonly he who comes in laft, draws firft. The perfon who draws the king fits where he pleafes, the queen at his right hand, the knave next the queen, and the ace on the left of the king. The king draws the favourite fuit. The number of cards and perfons is the fame at this game as the other, and is played in the fame manner.

The favourite fuit is determined by drawing a card out of the pack, and is of the fame fuit, during the whole party, of the card fo drawn.

A king is the mediateur, which is demanded of the others by one of the players, who has a hand he expects

pects to make five tricks of; and through the assistance of this king he can play alone and make six tricks.

In return for the king received, he gives what card he thinks proper with a fish; but must give two fish if it is in the favourite suit. He who asks by calling in the favourite suit, has the preference to him who asks by calling in any other; he who asks with the mediateur, has the preference to him who asks by calling in the favourite suit, and by playing alone is obliged to make six tricks to win. He who asks with the mediateur in the favourite suit, has the preference to him who asks with the mediateur in any other suit, and is obliged to play alone, and to make six tricks.

If sans prendre is played in any other suit than the favourite, he who plays it has the preference to him who asks only, or with the mediateur, or even he who plays in the favourite suit with the mediateur; and the sans prendre in the favourite suit has the preference to all other players whatever.

The only difference between this method of playing the game and the other is, that when one of the players demands the mediateur he is obliged to play alone, and to make six tricks, as if he played sans prendre. In this case he should judge from the strength of his hand, whether the aid of the king will enable him to play alone or not.

With the mediateur and without the favourite suit it is played in this manner. The game is marked and played the same as in common, except that a fish extraordinary is given to him who plays the mediateur, and to him who plays sans prendre; that is, he who wins the mediateur receives 13 counters from each; and if he loses by remise he pays 12 to each; and 13 if by codill. The winner of sans prendre receives 17 counters from each; and if by remise he loses, he pays 16 to each, and 17 if by codill.

The vole with the mediateur receives one fish only, as at common quadrille. The beasts are also the same as the common game. The last game is generally played double, and is called *paulans*; but for those who choose to play a higher game, they may play the double colour, which is called the *Turk*, and is double of the favourite suit. There is also a higher game than this called the *avóde*, which is paying whatever is agreed to him who happens to hold the two aces in his hand.

We have omitted many things respecting the mode of marking the game, and playing the vole, because these are different in different cases, and are to be learned only by practice. The game itself is a very inferior one; but he who wishes to know more of it, may consult Hoyle's games improved by James Beaufort, Esq; from which we have, with very little alteration, taken this article.

QUADRUPEDS, in zoology; those animals which have four limbs or legs proceeding from the trunk of their body. See ZOOLOGY; in which article notice will be taken of the method of preserving specimens of these and other animals.

QUÆSTOR, see QUESTOR.

QUAGGA, or QUACHA. See EQUUS, n° 5.

QUAIL, in zoology, See TETRAO.

Quails are to be taken by means of the call during their whole wooing time, which lasts from April to August. The proper times for using the call are at sun-rising, at nine o'clock in the morning, at three in the afternoon, and at sun-set; for these are the natural times of the quail's calling. The notes of the cock and hen quail are very different; and the sportsman who expects to succeed in the taking them must be expert in both: for when the cock calls, the answer is to be made in the hen's note; and when the hen calls, the answer is to be made in the cock's. By this means they will come up to the person, so that he may, with great ease, throw the net over them and take them. If a cock-quail be single, on hearing the hen's note he will immediately come; but if he have a hen already with him, he will not forsake her. Sometimes, though only one quail answers to the call, there will three or four come up; and then it is best to have patience, and not run to take up the first, but stay till they are all entangled, as they will soon be.

The quail is a neat cleanly bird, and will not run much into dirty or wet places: in dewy mornings, they will often fly instead of running to the call; and in this case, it is best to let them go over the net, if it so happens that they fly higher than its top; and the sportsman then changing sides, and calling again, the bird will come back, and then will probably be taken in the net.

The calls are to be made of a small leather purse, about two fingers wide, and four fingers long, and made in the shape of a pear; this is to be stuffed half-full of horse-hair, and at the end of it is to be placed a small whistle, made of the bone of a rabbit's leg, or some other such bone: this is to be about two inches long, and the end formed like a flageolet, with a little soft wax. This is to be the end fastened into the purse; the other is to be closed up with the same wax, only that a hole is to be opened with a pin, to make it give a distinct and clear sound. To make this sound, it is to be held full in the palm of the hand, with one of the fingers placed over the top of the wax; then the purse is to be pressed, and the finger is to shake over the middle of it, to modulate the sound it gives into a sort of shake. This is the most useful call; for it imitates the note of the hen-quail, and seldom fails to bring a cock to the net if there be one near the place.

The call that imitates the note of the cock, and is used to bring the hen to him, is to be about four inches long, and above an inch thick; it is to be made of a piece of wire turned round and curled, and covered with leather; and one end of it must be closed up with a piece of flat wood, about the middle of which there must be a small thread or strap of leather, and at the other end is to be placed the same sort of pipe, made of bone, as is used in the other call. The noise is made by opening and closing the spiral, and gives the same sound that the cock does when he gives the hen a signal that he is near her.

QUAKERS, a religious society, which took its rise in England about the middle of the last century, and rapidly found its way into other countries in Europe, and into the English settlements in North America.—The members of this society, we believe, called themselves at first *seekers*, from their *seeking* the truth; but after the society was formed, they assumed the appellation of *friends*. The name of *quakers* was given to them by their enemies; and though an epithet of reproach, seems to be stamped upon them indelibly. Their founder

Quakers.

der is generally believed to have been George Fox, an illiterate ſhoemaker (ſee *George Fox*), but this opinion has been lately controverted. An ingenious writer ‡ having found, or fancied, a ſimilarity of ſentiments among the ancient Druids and modern Quakers, ſeems to think that Fox muſt have been nothing more than a tool employed by certain deiſts to pave the way for their ſyſtem of natural religion, by allegorizing the diſtinguiſhing articles of the Chriſtian faith.

‡ See *Montb. Rev.* Sept. 1793, art. 5.

It muſt be confeſſed, for experience will not allow it to be denied, that extremes in religion are very apt to beget each other; and if the deiſts alluded to reaſoned from this fact, they could not have pitched upon a tool fitter for their purpoſe than George Fox. From his works ſtill extant, he appears to have been one of the moſt extravagant and abſurd enthuſiaſts that ever lived, and to have fancied himſelf, in his apoſtolic character, ſomething infinitely ſuperior to man. In a book called *News coming out of the North* (p. 15.) he ſays of himſelf, "I am the Door that ever was, the ſame Chriſt yeſterday, to-day, and for ever:" And in the introduction to his *Battle-door for Teachers and Profeſſors*, he ſays, "All languages are to me no more than duſt, who was before languages were." But one of the moſt extraordinary and blaſphemous things that he ever wrote, is an anſwer to the Protector, who had required him to promiſe not to diſturb his government as then eſtabliſhed. It is as follows:

"I who am of the world called G: F doth deny the carrying or drawing any carnal ſword againſt any, or againſt thee O: C: or any man, in the preſence of the Lord I declare it, God is my witneſs, by whom I am moved to give this forth for the truth's ſake, from him whom the world calls G: Fox, *who is the ſon of God*, who is ſent to ſtand a witneſs againſt all violence and againſt the works of darkneſs, and to turn the people from darkneſs to light, and to bring them from the occaſion of the war and from the occaſion of the magiſtrates ſword, which is a terror to the evil doer, which acts contrary to the light of the Lord *Jeſus Chriſt*; which is a praiſe to them that do well; which is a protection to them that do well, and not the evil; and ſuch ſoldiers as are put in place no falſe accuſers muſt be, no violence muſt do, but be content with their wages: and that magiſtrate bears not the ſword in vain, from under the occaſion of that ſword do I ſeek to bring people: my weapons are not carnal but ſpiritual, and *my kingdom is not of this world*; therefore with carnal weapon I do not fight, but am from thoſe things dead, from him who is not of this world, called of the world by the name of G: F: and this I am ready to ſeal with my blood; this I am moved to give forth for the truth's ſake, who a witneſs ſtands againſt all unrighteouſneſs, and all ungodlineſs, who a ſufferer is for the righteous ſeed's ſake, waiting for the redemption of it, who a crown that is mortal ſeeks not, for that fadeth away; but in the light dwells which comprehends that crown, which light is the condemnation of all ſuch, in which light I witneſs the crown that is immortal, which fades not away from him who to all your ſouls is a friend, for eſtabliſhing of righteouſneſs, and clearing the land of evil doers, and a witneſs againſt all the wicked inventions of man, and murderer's plots, which anſwer ſhall be with the light in all your conſciences, which makes no covenant with death; to which light in you all I ſpeak, and am clear, G: F: who a new name hath, which the world knows not." (A).

The Quakers, however, did not long entruſt the defence of their principles to ſuch ſenſeleſs enthuſiaſts as George Fox: They were joined by a number of learned, ingenious, and pious men, who new-modelled their creed; and though they did not bring it to what is generally deemed the Chriſtian ſtandard, they ſo reformed it as that its tenets do not ſhock common ſenſe, nor the duties preſcribed ſcandalize a man of piety. The chief of theſe reformers were George Keith, the celebrated Penn, and our countryman Barclay. Keith was indeed excommunicated for the liberties which he took with the great apoſtle; but we have not a doubt but his writings contributed to the moderation of Penn, and to the elegant and maſterly apology of Barclay. From that apology we ſelected the ſummary of their opinions which was given in the former edition of this work; but they have lately publiſhed ſuch a ſummary themſelves, of which the reader will be pleaſed with the following abſtract:

They tell us, that about the beginning of the 17th century, a number of men, diſſatisfied with all the modes of religious worſhip then known in the world, withdrew from the communion of every viſible church to ſeek the Lord in retirement. Among theſe was their *honourable elder George Fox*, who being quickened by the immediate touches of divine love, could not ſatisfy his apprehenſions of duty to God without directing the people where to find the like conſolation and inſtruction. In the courſe of his travels, he met with many ſeeking perſons in circumſtances ſimilar to his own, and theſe readily received his teſtimony. They then give us a ſhort account of their ſufferings and different ſettlements; and with a degree of candour which does them infinite credit, they vindicate Charles II. from the character of a perſecutor; acknowledging, that though they ſuffered much during his reign, he gave as little countenance as he could to the ſeverities of the legiſlature. They even tell us, that he exerted his influence to reſcue their friends from the unprovoked and cruel perſecutions of the New England fanatics; and they ſpeak with becoming gratitude of the different acts paſſed in their favour during the reigns of William and Mary, and George I. They then proceed to give us the following account of their doctrine:

"We

(A) We have tranſcribed this letter from the theological works of Mr Leſlie, where it is preſerved in its original form. The Quakers, after the death of their apoſtle, expunged from their edition of it the words which we have printed in Italics; aſhamed, as we hope, of the blaſphemy imputed to them: but that Mr Leſlie's copy is authentic, is thus atteſted by two of the friends, who ſaw Fox deliver it to the protector's meſſenger; "We are witneſſes of this teſtimony, whoſe names in the fleſh are, *Tho. Aldam.* *Rob. Craven.*

"We agree with other professors of the Christian name, in the belief in one eternal God, the Creator and Preserver of the universe; and in Jesus Christ his Son, the Messiah, and Mediator of the new covenant (Heb. xii. 24).

"When we speak of the gracious display of the love of God to mankind, in the miraculous conception, birth, life, miracles, death, resurrection, and ascension of our Saviour, we prefer the use of such terms as we find in Scripture; and, contented with that knowledge which divine wisdom hath seen meet to reveal, we attempt not to explain those mysteries which remain under the veil; nevertheless, we acknowledge and assert the divinity of Christ, who is the wisdom and power of God unto salvation (1 Cor. i. 24).

"To Christ alone we give the title of the Word of God (John i. 1.) and not to the Scriptures; although we highly esteem these sacred writings, in subordination to the Spirit (2 Pet. i. 21.), from which they were given forth; and we hold, with the apostle Paul, that they are able to make wise unto salvation, through faith which is in Christ Jesus (2 Tim. iii. 15).

"We reverence those most excellent precepts which are recorded in Scripture to have been delivered by our great Lord, and we firmly believe that they are practicable, and binding on every Christian; and that in the life to come every man will be rewarded according to his works (Mat. xvi. 27). And farther, it is our belief, that, in order to enable mankind to put in practice these sacred precepts, many of which are contradictory to the unregenerate will of man (John i. 9.), every man coming into the world is endued with a measure of the light, grace, or good Spirit of Christ; by which, as it is attended to, he is enabled to distinguish good from evil, and to correct the disorderly passions and corrupt propensities of his nature, which mere reason is altogether insufficient to overcome. For all that belongs to man is fallible, within the reach of temptation; but this divine grace, which comes by Him who hath overcome the world (John xvi. 33.) is, to those who humbly and sincerely seek it, an all-sufficient and present help in time of need. By this the snares of the enemy are detected, his allurements avoided, and deliverance is experienced through faith in its effectual operation; whereby the soul is translated out of the kingdom of darkness, and from under the power of Satan, into the marvellous light and kingdom of the Son of God.

"Being thus persuaded that man, without the Spirit of Christ inwardly revealed, can do nothing to the glory of God, or to effect his own salvation; we think this influence especially necessary to the performance of the highest act of which the human mind is capable, even the worship of the Father of lights and of spirits, in spirit and in truth; therefore we consider as obstructions to pure worship, all forms which divert the attention of the mind from the secret influence of this unction from the Holy One (1 John ii. 20, 27). Yet, although true worship is not confined to time and place, we think it incumbent on Christians to meet often together (Heb. x. 25.) in testimony of their dependence on the heavenly Father, and for a renewal of their spiritual strength: nevertheless, in the performance of worship, we dare not depend, for our acceptance with Him, on a formal repetition of the words and experiences of others; but we believe it to be our duty to cease from the activity of the imagination, and to wait in silence to have a true sight of our condition bestowed upon us: believing even a single sigh (Rom. viii. 26.) arising from such a sense of our infirmities, and of the need we have of divine help, to be more acceptable to God, than any performances, however specious, which originate in the will of man.

"From what has been said respecting worship, it follows, that the ministry we approve must have its origin from the same source: for that which is needful for a man's own direction, and for his acceptance with God (Jer. xxiii. 30, to 32.) must be eminently so to enable him to be helpful to others. Accordingly, we believe the renewed assistance of the light and power of Christ to be indispensably necessary for all true ministry; and that this holy influence is not at our command, or to be procured by study, but is the free gift of God to his chosen and devoted servants.—From hence arises our testimony against preaching for hire, and in contradiction to Christ's positive command, "Freely ye have received, freely give;" (Mat. x. 8.) and hence our conscientious refusal to support such ministry by tithes or other means.

"As we dare not encourage any ministry but that which we believe to spring from the influence of the Holy Spirit, so neither dare we attempt to restrain this influence to persons of any condition in life, or to the male sex alone; but, as male and female are one in Christ, we allow such of the female sex as we believe to be endued with a right qualification for the ministry, to exercise their gifts for the general edification of the church: and this liberty we esteem to be a peculiar mark of the gospel dispensation, as foretold by the prophet Joel (Joel ii. 28, 29.) and noticed by the apostle Peter (Acts ii. 16, 17).

"There are two ceremonies in use amongst most professors of the Christian name; Water-baptism, and what is termed the Lord's Supper. The first of these is generally esteemed the essential means of initiation into the church of Christ; and the latter of maintaining communion with him. But as we have been convinced, that nothing short of his redeeming power, inwardly revealed, can set the soul free from the thraldom of sin, by this power alone we believe salvation to be effected. We hold that as there is one Lord and one faith (Eph. iv. 5.), so his baptism is one in nature and operation; that nothing short of it can make us living members of his mystical body; and that the baptism with water, administered by his fore-runner John, belonged, as the latter confessed, to an inferior and decreasing dispensation (John iii. 30).

"With respect to the other rite, we believe that communion between Christ and his church is not maintained by that nor any other external performance, but only by a real participation of his divine nature (2 Pet. i. 4.) through faith; that this is the supper alluded to in the Revelation (Rev. iii. 20.), "Behold I stand at the door and knock, if any man hear my voice, and open the door, I will come in to him, and will sup with him, and he with me;" and that where the substance is attained, it is unnecessary to attend to the shadow, which doth not confer grace, and concerning which opinions so different, and animosities so violent, have arisen.

"Now, as we thus believe that the grace of God, which comes by Jesus Christ, is alone sufficient for salvation,

Quakers.

vation, we can neither admit that it is conferred on a few only, whilst others are left without it; nor, thus asserting its universality, can we limit its operation to a partial cleansing of the soul from sin, even in this life. We entertain worthier notions both of the power and goodness of our heavenly Father, and believe that he doth vouchsafe to assist the obedient to experience a total surrender of the natural will to the guidance of his pure unerring Spirit; through whose renewed assistance they are enabled to bring forth fruits unto holiness, and to stand perfect in their present rank (Mat. v. 48.; Eph. iv. 13.; Col. iv. 12.)

"There are not many of our tenets more generally known than our testimony against oaths and against war. With respect to the former of these, we abide literally by Christ's positive injunction, delivered in his sermon on the mount, "Swear not at all" (Mat. v. 34)*. From the same sacred collection of the most excellent precepts of moral and religious duty, from the example of our Lord himself (Mat. ch. v. 39, 44, &c. ch. xxvi. 52, 53.; Luke xxii. 51.; John xviii. 11.), and from the correspondent convictions of his Spirit in our hearts, we are confirmed in the belief that wars and fightings are, in their origin and effects, utterly repugnant to the Gospel, which still breathes peace and good-will to men. We also are clearly of the judgment, that if the benevolence of the Gospel were generally prevalent in the minds of men, it would effectually prevent them from oppressing, much more from enslaving, their brethren, (of whatever colour or complexion), for whom, as for themselves, Christ died; and would even influence their conduct in their treatment of the brute creation, which would no longer groan the victims of their avarice, and of their false ideas of pleasure.

* See *Oath.*

"Some of our tenets have in former times, as hath been shown, subjected our friends to much suffering from government, though to the salutary purposes of government our principles are a security. They inculcate submission to the laws in all cases wherein conscience is not violated. But we hold, that as Christ's kingdom is not of this world, it is not the business of the civil magistrate to interfere in matters of religion; but to maintain the external peace and good order of the community. We therefore think persecution, even in the smallest degree, unwarrantable. We are careful in requiring our members not to be concerned in illicit trade, nor in any manner to defraud the revenue.

"It is well known that the society, from its first appearance, has disused those names of the months and days which, having been given in honour of the heroes or false gods of the heathens, originated in their flattery or superstition; and the custom of speaking to a single person in the plural number (B), as having arisen also from motives of adulation. Compliments, superfluity of apparel and furniture, outward shows of rejoicing and mourning, and observation of days and times, we esteem to be incompatible with the simplicity and sincerity of a Christian life; and public diversions, gaming, and other vain amusements of the world, we cannot but condemn. They are a waste of that time which is given us for nobler purposes, and divert the attention of the mind from the sober duties of life, and from the reproofs of instruction, by which we are guided to an everlasting inheritance.

"To conclude, although we have exhibited the several tenets which distinguish our religious society, as objects of our belief, yet we are sensible that a true and living faith is not produced in the mind of man by his own effort; but is the free gift of God (Eph. ii. 8.) in Christ Jesus, nourished and increased by the progressive operation of his spirit in our hearts, and our proportionate obedience (John vii. 17.). Therefore, although, for the preservation of the testimonies given us to bear, and for the peace and good order of the society, we deem it necessary that those who are admitted into membership with us, should be previously convinced of those doctrines which we esteem essential; yet we require no formal subscription to any articles, either as the condition of membership, or to qualify for the service of the church. We prefer the judging of men by their fruits, in a dependence on the aid of Him who, by his prophet, hath promised to be "a spirit of judgment to him that sitteth in judgment" (Isaiah xxviii. 6). Without this, there is a danger of receiving numbers into outward communion, without any addition to that spiritual sheepfold, whereof our blessed Lord declared himself to be both the door and the shepherd (John x. 7, 11.) that is, such as know his voice, and follow him in the paths of obedience."

Such are the doctrines of this people as we find them stated in a small pamphlet lately presented by themselves to the public; and in the same tract they give the following account of their discipline.

"In the practice of discipline, we think it indispensable that the order recommended by Christ himself be invariably observed: (Matth. xviii. 15. to 17.) 'If thy brother shall trespass against thee, go and tell him his fault between thee and him alone: if he shall hear thee, thou hast gained thy brother; but if he will not hear thee, then take with thee one or two more, that in the mouth of two or three witnesses every word may be established; and if he shall neglect to hear them, tell it unto the church.'

"To effect the salutary purposes of discipline, meetings were appointed, at an early period of the society, which, from the times of their being held, were called quarterly-meetings. It was afterwards found expedient to divide the districts of those meetings, and to meet more often; whence arose monthly-meetings, subordinate to those held quarterly. At length, in 1669, a yearly-meeting was established, to superintend, assist, and provide, rules for the whole; previous to which, general meetings had been occasionally held.

"A monthly-meeting is usually composed of several particular congregations, situated within a convenient distance of each other. Its business is to provide for the subsistence of their poor, and for the education of of their offspring; to judge of the sincerity and fitness of persons appearing to be convinced of the religious principles of the society, and desiring to be admitted into

(B) Speaking of this custom, Fox says: "When the Lord sent me into the world, he forbad me to put off my hat to any; and I was required to *thee* and *thou* all men and women." *Journal*, p. 24.

Quaker.

into membership; to excite due attention to the discharge of religious and moral duty; and to deal with disorderly members. Monthly-meetings also grant to such of their members as remove into other monthly-meetings, certificates of their membership and conduct; without which they cannot gain membership in such meetings. Each monthly-meeting is required to appoint certain persons under the name of *overseers*, who are to take care that the rules of our discipline be put in practice; and when any case of complaint or disorderly conduct comes to their knowledge, to see that private admonition, agreeable to the gospel rule before-mentioned, be given previously to its being laid before the monthly-meeting.

"When a case is introduced, it is usual for a small committee to be appointed to visit the offender, to endeavour to convince him of his error, and to induce him to forsake and condemn it. If they succeed, the person is by minute declared to have made satisfaction for the offence; if not, he is disowned as a member of the society.

"In disputes between individuals, it has long been the decided judgment of the society that its members should not sue each other at law. It therefore enjoins all to end their differences by speedy and impartial arbitration, agreeable to rules laid down. If any refuse to adopt this mode, or, having adopted it, to submit to the award, it is the direction of the yearly-meeting that such be disowned.

"To monthly-meetings also belongs the allowing of marriages; for our society hath always scrupled to acknowledge the exclusive authority of the priests in the solemnization of marriage. Those who intend to marry, appear together and propose their intention to the monthly-meeting; and if not attended by their parents or guardians, produce a written certificate of their consent, signed in the presence of witnesses. The meeting then appoints a committee to inquire whether they are clear of other engagements respecting marriage; and if at a subsequent meeting, to which the parties also come and declare the continuance of their intention, no objections are reported, they have the meeting's consent to solemnize their intended marriage. This is done in a public meeting for worship; towards the close whereof the parties stand up, and solemnly take each other for husband and wife. A certificate of the proceedings is then publicly read, and signed by the parties, and afterwards by the relations and others as witnesses. Of such certificates the monthly-meeting keeps a record; as also of the births and burials of its members. A certificate of the date, of the name of the infant, and of its parents, signed by those present at the birth, is the subject of one of these last-mentioned records; and an order for the interment, countersigned by the grave-maker, of the other. The naming of children is without ceremony. Burials are also conducted in a simple manner. The body, followed by the relations and friends, is sometimes, previously to interment, carried to a meeting; and at the grave a pause is generally made; on both which occasions it frequently falls out that one or more friends present have somewhat to express for the edification of those who attend; but no religious rite is considered as an essential part of burial.

"Several monthly-meetings compose a quarterly-meeting. At the quarterly-meeting are produced written answers from the monthly-meetings, to certain queries respecting the conduct of their members, and the meeting's care over them. The accounts thus received are digested into one, which is sent, also in the form of answers to queries, by representatives, to the yearly-meeting.—Appeals from the judgment of monthly-meetings are brought to the quarterly-meetings; whose business also it is to assist in any difficult case, or where remissness appears in the care of the monthly-meetings over the individuals who compose them.

"The yearly-meeting has the general superintendance of the society in the country in which it is established (c); and therefore, as the accounts which it receives discover the state of inferior meetings, as particular exigencies require, or as the meeting is impressed with a sense of duty, it gives forth its advice, makes such regulations as appear to be requisite, or excites to the observance of those already made; and sometimes appoints committees to visit those quarterly-meetings which appear to be in need of immediate help. Appeals from the judgment of quarterly-meetings are here finally determined; and a brotherly correspondence, by epistles, is maintained with other yearly-meetings.

"In this place it is proper to add, that as we believe women may be rightly called to the work of the ministry, we also think, that to them belongs a share in the support of our Christian discipline; and that some parts of it, wherein their own sex is concerned, devolve on them with peculiar propriety. Accordingly they have monthly, quarterly, and yearly-meetings of their own sex, held at the same time and in the same place with those of the men; but separately, and without the power of making rules: and it may be remarked, that during the persecutions, which in the last century occasioned the imprisonment of so many of the men, the care of the poor often fell on the women, and was by them satisfactorily administered.

"In order that those who are in the situation of ministers may have the tender sympathy and counsel of those of either sex, who, by their experience in the work of religion, are qualified for that service; the monthly-meetings are advised to select such, under the denomination of *elders*. These, and ministers approved by their monthly-meetings (D), have meetings peculiar to themselves, called meetings of ministers and elders; in

(c) "There are seven yearly meetings, viz. 1st, London, to which come representatives from Ireland; 2d, New-England; 3d, New-York; 4th, Pennsylvania and New-Jersey; 5th, Maryland; 6th, Virginia; 7th, the Carolinas and Georgia."

(D) "Those who believe themselves required to speak in meetings for worship, are not immediately acknowledged as ministers by their monthly-meetings; but time is taken for judgment, that the meeting may be satisfied of their call and qualification. It will also sometimes happen, that such as are not approved, will obtrude themselves as ministers, to the grief of their brethren; but much forbearance is used towards these, before the disapprobation of the meeting is publicly testified."

Quaker.

in which they have an opportunity of exciting each other to a difcharge of their feveral duties, and of extending advice to thofe who may appear weak, without any needlefs expofure. Thefe meetings are generally held in the compafs of each monthly, quarterly, and yearly-meeting. They are conducted by rules prefcribed by the yearly-meeting, and have no authority to make any alteration or addition to them. The members of them unite with their brethren in the meetings for difcipline, and are equally accountable to the latter for their conduct.

"It is to a meeting of this kind held in London, called the fecond-day morning-meeting, that the revifal of manufcripts concerning our principles, previoufly to publication, is intrufted by the yearly-meeting held in London; and alfo the granting, in the intervals of the yearly-meeting, certificates of approbation to fuch minifters as are concerned to travel in the work of the miniftry in foreign parts. When a vifit of this kind doth not extend beyond Great Britain, a certificate from the monthly-meeting of which the minifter is a member is fufficient; if to Ireland, the concurrence of the quarterly-meeting is alfo required. Regulations of fimilar tendency obtain in other yearly-meetings.

"The yearly-meeting held in London, in the year 1675, appointed a meeting to be held in that city, for the purpofe of advifing and affifting in cafes of fuffering for confcience fake, which hath continued with great ufe to the fociety to this day. It is compofed of friends under the name of correfpondents, chofen by the feveral quarterly-meetings, and who refide in or near the city. The fame meetings alfo appoint members of their own in the country as correfpondents, who are to join their brethren in London on emergency. The names of all thefe correfpondents, previous to their being recorded as fuch, are fubmitted to the approbation of the yearly-meeting. Thofe of the men who are approved minifters are alfo members of this meeting, which is called the *meeting* for *fufferings;* a name arifing from its original purpofe, which is not yet become entirely obfelete.

"The yearly-meeting has intrufted the meeting for fufferings with the care of printing and diftributing books, and with the management of its ftock; and confidered as a ftanding committee of the yearly-meeting, it hath a general care of whatever may arife, during the intervals of that meeting, affecting the fociety, and requiring immediate attention: particularly of thofe circumftances which may occafion an application to government.

"There is not in any of the meetings which have been mentioned any prefident, as we believe that Divine Wifdom alone ought to prefide; nor hath any member a right to claim pre-eminence over the reft. The office of clerk, with a few exceptions, is undertaken voluntarily by fome member; as is alfo the keeping of the records. Where thefe are very voluminous, and require a houfe for their depofite (as is the cafe in London, where the general records of the fociety in Great Britain are kept), a clerk is hired to have the care of them; but except a few clerks of this kind, and perfons who have the care of meeting-houfes, none receive any ftipend or gratuity for their fervices in our religious fociety."

It is remarkable, that all the fettlements of the Europeans in America, except the Quaker fettlement of Pennfylvania, were made by force of arms, with very little regard to any prior title in the natives. The kings of Spain, Portugal, France, and Britain, together with the States of Holland, then the only maritime powers, gave grants of fuch parts of America as their people could lay hold on, ftudying only to avoid interference with their European neighbours. But Mr Penn, being a Quaker, did not think his power from King Cha. II. a fufficient title to the country fince called *Pennfylvania:* He therefore affembled the fachems or princes then in that country, and purchafed from them the extent of land that he wanted. The government of this province is moftly in the hands of the Quakers, who never have any quarrels with the natives. When they defire to extend their fettlements, they purchafe new lands of the fachems, never taking any thing from them by force. How unlike is this conduct to that of the Spaniards, who murdered millions of the natives of Mexico, Terra Firma, Peru, Chili, &c.

Quality characterized by Ariftotle.

QUALITY is a word which, as ufed in philofophical difquifitions, cannot be explained by any periphrafis. That which is expreffed by it muft be brought into the immediate view of the fenfes or intellect, and the name properly applied, or he who is a ftranger to the word will never be made to comprehend its meaning. Ariftotle, who treated it as a general conception fecond in order among the ten *predicaments* or *categories* (fee CATEGORY), gives feveral characters of it; but though they are all in fome refpects juft, no man could from them, without other affiftance, learn what *quality* is. Thus he tells us *, Υ'παρχει δε εναντιοτης κατα το ποιον; Επιδεχεται δε το μαλλον και το ἡττον τα ποια. And again, Ο'μοια δε η ανομοια κατα μονας τας ποιοτητας λεγεται· ὁμοιον γαρ ἑτερον ἑτερῳ ουκ εστι κατ' αλλο ουδεν, η καθ' ὁ ποιον εστιν.

* *Præd.* Sylb. p. 45.

When a man comprehends, by means of his fenfes and intellect, what it is which the word *quality* denotes, he will indeed perceive that the firft of thefe characters is applicable to fome qualities and not to others; that the fecond is more applicable to *quantity* than to quality; and that it is only the third which can with propriety be confidered as the general characteriftic of this predicament. Thus when we have learned by our fenfe of fight that *whitenefs* is a quality of fnow, and *blacknefs* of coal; and by means of obfervation and reflection, that *wifdom* is a quality of one man and *folly* of another—we muft admit that the fenfible quality of the fnow is *contrary* to that of the coal, and the intellectual quality of wifdom contrary to that of folly. There is, however, no contrariety between *wifdom* and *whitenefs* or *blacknefs*, nor between *hardnefs* or *foftnefs*, and *any particular colour;* for fenfible and intellectual qualities can never be compared; and it is not eafy, if poffible, to make a comparifon between qualities perceptible only by different fenfes: Nay, among qualities perceptible by the fame fenfe, we often meet with a difference where there is no contrariety; for though the *figure* of a *cube* is *different* from that of a *fphere*, and the figure of a *fquare* from that of a *circle*, the fphere is not *contrary* to the cube, nor the circle to the fquare.

His fecond characteriftic of this genus is ftill lefs proper than the firft. It is indeed true that fome qualities admit of *intenfion* and *remiffion;* for fnow is whiter than paper, and one woman is handfomer than another; but

ality. of the ſpecies of quality called *figure* we cannot predicate either *more* or *leſs*. A crown-piece may have as much of the *circular quality* in it as the plane of the equator, and a muſket-bullet as much of the *ſpherical quality* as the orb of the ſun. It is indeed a property of all *quantity* to admit of *intenſion* and *remiſſion*; and therefore this ought to have been given as the character not of the ſecond but of the third category. See QUANTITY.

2 hing wn but lities. That it is only from a *compariſon of their qualities that things are denominated like or unlike*, or that *one thing cannot reſemble another but in ſome quality*, is indeed a juſt obſervation. We know nothing directly but qualities ſenſible and intellectual (ſee METAPHYSICS, n° 149, 150, 151, and 227); and as theſe have no reſemblance to each other, we conclude that body or matter, the ſubject of the former, is a being unlike mind, the ſubject of the latter. Even of bodies themſelves we can ſay, that one is like or unlike another only by virtue of their qualities. A ball of ivory reſembles a ball of ſnow in its *figure* and *colour*, but not in its *coldneſs* or *hardneſs*; a ball of lead may reſemble a ball of ſnow in its *figure* and *coldneſs*, but not in its *colour*; and a cube of ivory reſembles not a ball of lead either in *figure*, *colour*, or *coldneſs*. The mind of a brute reſembles that of a man in its powers of *ſenſation* and *perception*, but does not reſemble it in the powers of *volition* and *reaſoning*; or at leaſt, the reſemblance, in this latter inſtance, is very ſlight. All bodies reſemble one another in being ſolid and extended, and all minds in being more or leſs active. *Likeneſs* or *unlikeneſs* therefore is the univerſal characteriſtic of the category *quality*.

3 portant inctions quality. Ariſtotle has other ſpeculations reſpecting quality, which are worthy of notice. He diſtinguiſhes between qualities which are *eſſential* and thoſe which are *accidental*; between qualities which are *natural* and thoſe which are *acquired*; and he ſpeaks of the qualities of *capacity* and thoſe of *completion*. *Extenſion* and *figure* in *general* are qualities eſſential to all bodies; but a *particular* extenſion, ſuch as an *inch* or an *ell*, and a *particular* figure, ſuch as a *cube* or a *ſphere*, are qualities accidental to bodies. Among the *natural* qualities of glaſs it is one to tranſmit objects of viſion; but to enlarge theſe objects is an *adventitious* or *acquired* quality. The ſame quality may be *natural* in one ſubſtance, as attraction in the magnet; and *acquired* in another, as the ſame attraction in the magnetic bar. *Docility* may be called a quality *natural* to the mind of man, ſcience an *acquired* one. To underſtand what he means by qualities of *capacity* and *completion*, it may be ſufficient to obſerve that every piece of iron has the qualities of a razor in *capacity*, becauſe it may be converted into ſteel, and formed into a razor: when it is ſo formed, it has, in the language of this ſage, the quality of a razor in *completion*. Among the qualities of *capacity* and *completion*, the moſt important, and what may lead to intereſting ſpeculations, is the reaſoning faculty of man. A *capacity* of reaſoning is eſſential to the human mind; but the *completion* of this capacity or *actual reaſoning* is not; otherwiſe *infants* and perſons *aſleep* would be excluded from the human ſpecies.

4 erlooked Locke. Book iv. 4. § 13. Mr Locke has puzzled his readers, and perhaps himſelf, with a queſtion reſpecting the ſpecies of an idiot or changeling, whom he pronounces to be ſomething between a man and a brute *. It is not often that we feel ourſelves inclined to regret Locke's ignorance of Ariſtotle's diſtinctions; but we cannot help thinking, that had the Britiſh philoſopher attended to the Stagyrite's account of qualities in *capacity* and qualities in *completion*, this perplexing queſtion would never have been ſtarted. It is juſtly obſerved in the *Eſſay on Human Underſtanding*, that of *real eſſences* we know nothing: but that every man ſelects a certain number of qualities which he has always perceived united in certain beings; and forming theſe into one complex conception, gives to this conception a *ſpecific* name, which he applies to every being in which he finds thoſe qualities united. This is undoubtedly the proceſs of the mind in forming genera and ſpecies; and as the excellent author refuſes the name of *man* to the changeling, it is obvious that the complex conception, to which he gives that name, muſt imply *rationality* or the *actual exerciſe* of reaſon. But this limitation will exclude many beings from the ſpecies *man*, whom Mr Locke certainly conſidered as men and women. Not to mention infants and perſons in ſound ſleep, how ſhall we claſs thoſe who, after having lived 30 or 40 years in the full exerciſe of reaſon, have been ſuddenly or by degrees deprived of it by ſome diſorder in the brain?

5 Strange conſequence of this overſight.

> From Marlb'rough's eyes the ſtreams of dotage flow;
> And Swift expires a driveller and a ſhow.
>
> JOHNSON.

But were the hero and the wit in thoſe deplorable circumſtances excluded from the human ſpecies, and claſſed between men and brutes? No ſurely; they were both acknowledged to be men, becauſe they were known to have the quality of reaſon in what Ariſtotle would have called *capacity*. Their dotage and drivelling originated from ſome diſorder in their bodies, probably in the region of the brain; and Locke himſelf contends that no defect in body is ſufficient to degrade a perſon from the rank of manhood. Again, lunatics have the exerciſe of reaſon, except at new and full moon. Are theſe unhappy beings ſometimes men and ſometimes a ſpecies by themſelves between men and brutes?

It appears, therefore, that *not* the *actual exerciſe* of reaſon, but reaſon in *capacity*, ought to be included in the complex conception to which we give the ſpecific name of *man*, as ſome of the greateſt men that ever lived have been during parts of their lives deprived of the power of *actual reaſoning*. This, however, it will be ſaid, does not remove the difficulty; for the occaſional exerciſe of reaſon in lunatics, and the great exertions of it in ſuch men as Swift and Marlborough, ſhow that they had it in *capacity* at all times; whereas we have no evidence that changelings have even a *capacity* of reaſoning at any time, ſince they never do a rational action, nor ever utter a ſentence to the purpoſe. That we have no *direct* and *poſitive* evidence of the minds of changelings being capable of reaſoning, were they ſupplied with proper organs, muſt be granted; but the probabilities of their being ſo are many and great. We know by experience that the actual exerciſe of reaſon may be interrupted by an occaſional and accidental preſſure on the brain: and therefore we cannot doubt but that if this preſſure were rendered permanent by any wrong configuration of the ſkull given to it in the womb, or in the act of being born into the world, an infant, with a mind capable of reaſoning by means of proper organs, would

Fallacy of his doctrine reſpecting the human ſpecies.

would by this accident be rendered, through the whole of life, an idiot or changeling. That idiotifm is caufed by fuch accidents, and is not the quality of an inferior mind occafionally given to a human body, will at leaft feem probable from the following confiderations.

7
True doctrine.

It does not appear that an animal body can live and move but while it is actuated by fome mind. Whence then does the unborn infant derive its mind? It muft be either immediately from God, or *ex traduce* from its parents; but if the mind of man be immaterial, it cannot be *ex traduce*. Now, as idiots are very few in number when compared with the rational part of the human fpecies, and as God in the government of this world acts not by partial but by general laws; we muft conclude that the law which he has eftablifhed refpecting the union of mind and matter, is, that human bodies fhall be animated with minds endowed with a capacity of reafoning, and that thofe who never exert this capacity are prevented by fome fuch accident as we have affigned.

For a further account of qualities, why they are fuppofed to inhere in fome fubject, together with the ufual diftinction between the primary and fecondary qualities of matter, fee METAPHYSICS, Part II. Chap. i.

Chemical QUALITIES, thofe qualities principally introduced by means of chemical experiments, as fumigation, amalgamation, cupellation, volatilization, precipitation, &c.

QUALITY, is alfo ufed for a kind of title given to certain perfons, in regard of their territories, figniories, or other pretenfions.

QUANGA, See CAPRA.

QUANG-PING-FOU, a city in China, is fituated in the northern part of the province of Pe-tcheli, between the provinces of Chang-tong and Ho-nan, and has nine cities of the third clafs dependent on it; all its plains are well watered by rivers. Among its temples, there is one dedicated to thofe men who, as the Chinefe pretend, difcovered the fecret of rendering themfelves immortal.

QUANGSI, a province of China, bounded on the north by Koe-Tcheau and Hu-Quang; on the eaft, by Yunan and Quantong; on the fouth, by the fame and Ton-quin; and on the weft, by Yun-nan. It produces great plenty of rice, being watered by feveral large rivers. The fouthern part is a flat country, and well cultivated; but the northern is full of mountains covered with trees. It contains mines of all forts; and there is a gold-mine lately opened. The capital town is Quie-ling.

A very fingular tree, fays Grofier, grows in this province; inftead of pith, it contains a foft pulp, which yields a kind of flour: the bread made of it is faid to be exceedingly good. Befides paroquets, hedgehogs, porcupines, and rhinocerofes, a prodigious number of wild animals, curious birds, and uncommon infects, are found here.

This province contains 12 villages of the firft clafs, and 80 of the fecond and third.

QUANG-TONG, a province of China, bounded on the eaft by Kiang-fi and Fokien; on the fouth, by the ocean; and on the weft, by Tonquin. This province is diverfified by valleys and mountains; and yields two crops of corn in a year. It abounds in gold, jewels, filk, pearls, tin, quickfilver, fugar, brafs, iron, fteel, falt-petre, ebony, and feveral forts of odoriferous wood; befides fruits of all forts proper to the climate. They have a prodigious number of ducks, whofe eggs they hatch in ovens; and a tree, whofe wood is remarkably hard and heavy, and thence called *iron-wood*. The mountains are covered with a fort of ofiers which creep along the ground, and of which they make bafkets, hurdles, matts, and ropes.

Although the climate of this province is warm, the air is pure, and the people are robuft and healthy. They are very induftrious; and it muft be allowed that they poffefs in an eminent degree the talent of imitation: if they are only fhown any of our European works, they execute others like them with the moft furprifing exactnefs. This province fuffered much during the civil wars; but at prefent it is one of the moft flourifhing in the empire; and, as it is at a great diftance from court, its government is one of the moft important. This province is divided into ten diftricts, which contain 10 cities of the firft clafs, and 84 of the fecond and third. Canton is the capital town.

1
Quantity.

QUANTITY, as explained by the great Englifh lexicographer, is that property of any thing which may be increafed or diminifhed. This interpretation of the *word* is certainly juft, and for the purpofes of common converfation it is fufficiently determinate; but the man of fcience may expect to find in a work like ours a definition of the *thing* fignified. This, however, cannot be given him. A logical definition confifts of the *genus* under which the thing defined is ranked, and the *fpecific* difference (fee LOGIC, n° 20, &c.); but quantity is ranked under no genus. In that fchool where fuch definitions were moft valued, it was confidered as one of the ten *categories*, or general conceptions, under which all the objects of human apprehenfion were muftered, like foldiers in an army (fee CATEGORY and PHILOSOPHY, n° 22.) On this account, even Ariftotle himfelf, who delighted in definitions, and was not eafily deterred from a favourite purfuit, could not confiftently with his own rules attempt to define *quantity*. He characterizes it, however, in feveral parts of his works; and particularly in the 15th chapter of the 4th book of his metaphyfics, where he gives the following account of the three firft *categories*: Ταυτα μεν γαρ, ὡν μια ἡ ουσια· ὁμοια δ' ὡν ἡ ποιοτης μια· ισα δε, ὡν το ποσον εν. "Things are the *fame*, of which the SUBSTANCE is one; *fimilar*, of which the QUALITY is one; *equal*, of which the QUANTITY is one. Again, he tells us*, that the chief characteriftic of quantity is, that it may be denominated *equal* and *unequal*.

2
Characterized by Ariftotle.

* *Præd.* p. 34. edit. Sylb.

That any man can become wifer by reading fuch defcriptions as thefe, none but an idolater of Ariftotle will fuppofe. There is, indeed, no periphrafis by which we can explain what is meant by quantity to thofe who have not previoufly formed fuch a notion.—All that can be done by making the attempt is only to fettle language, by ftating exactly the cafes in which we ufe this word in the greateft conformity to general cuftom; for there is a laxnefs or carelefsnefs of expreffion in the language of moft men, and our notions are frequently communicated by fpeech in a way by no means precife; fo that it is often a great chance that the notions excited in the mind of the hearer are not exact counterparts of thofe in the mind of the fpeaker.

The

Quantity.

The underſtandings of men differ in nothing more remarkably than in their power of abſtraction, and of rapidly forming conceptions ſo general and ſimple as not to be clogged with diſtinguiſhing circumſtances, which may be different in different minds while uttering and hearing the ſame words: and it is of great conſequence to a man of ſcientific habits, either to cultivate, if poſſible, this talent, or to ſuperſede its uſe, by ſtudiouſly forming to himſelf notions of the moſt important *univerſals* in his own courſe of contemplation, by careful abſtraction of every thing extraneous. His language by this means becomes doubly inſtructive by its extreme preciſion; and he will even judge with greater certainty of notions intended to be communicated by the more ſlovenly language of another perſon.

We cannot ſay that there is much ambiguity in the general uſe of the term *quantity*: But here, as in all other caſes, a love of refinement, of novelty, and frequently of vanity, and the wiſh of appearing ingenious and original, have made men take advantage of even the ſmall latitude with which the careleſs uſe of the word will furniſh them, to amuſe themſelves and the public by giving the appearance of ſcience to empty ſounds.

3 [The ſubject of mathematical reaſoning.]

Mathematics is undoubtedly employed in diſcovering and ſtating many relations of quantity; and it is in this category alone that any thing is contemplated by the mathematician, whether in geometry, arithmetic, or algebra. Hence mathematics has been called the ſcience of quantity. The ſimplicity of the object of the mathematician's contemplation, and the unparalleled diſtinctneſs with which he can perceive its modifications, have enabled him to erect a body of ſcience, eminent not only for its certainty, but alſo for the great length to which he can carry his reaſonings without danger of error; and the intimate connection which this ſcience has with the arts of life, and the important ſervices which it has performed, have procured it a moſt reſpectable place in the circle of the ſciences. Ingenious men have availed themſelves of this pre-eminence of mathematics, and have endeavoured to procure reſpect for their diſquiſitions on other ſubjects, by preſenting them to the public as branches of mathematical ſcience, and therefore ſuſceptible of that accuracy and certainty which are its peculiar boaſt. Our moral affections, our ſenſations, our intellectual powers, are all ſuſceptible of augmentation and diminution, are conceivable as greater and leſs when ſtated together, and are familiarly ſpoken of as admitting of degrees of compariſon. We are perfectly well underſtood when we ſay that one pain, heat, grief, kindneſs, is greater than another; and as this is the diſtinguiſhing characteriſtic of quantity, and as quantity is the ſubject of mathematical diſcuſſion, we ſuppoſe that theſe ſubjects may be treated mathematically. Accordingly, a very celebrated and excellent philoſopher* has ſaid, among many things of the ſame kind, that the greatneſs of a favour is in the direct compound ratio of the ſervice performed and the dignity of the performer, and the inverſe ratio of the merit and rank of the receiver; that the value of a character is in the compound ratio of the talents and virtue, &c.; and he has delivered a number of formal propoſitions on the moſt intereſting queſtions in morals, couched in this mathematical language, and even expreſſed by algebraic formulæ. But this is mere play, and conveys no inſtruction. We underſtand the words; they contain no abſurdity; and in as far as they have a ſenſe, we believe the propoſitions to be true. But they give no greater preciſion to our ſentiments than the more uſual expreſſions would do. If we attend cloſely to the meaning of any one of ſuch propoſitions, we ſhall find that it only expreſſes ſome vague and indiſtinct notions of degrees of thoſe emotions, ſentiments, or qualities, which would be juſt as well conceived by means of the expreſſions of ordinary language; and that it is only by a ſort of analogy or reſemblance that this mathematical language conveys any notions whatever of the ſubjects.

* Dr Francis Hutcheson.

4 [Which is improperly introduced into other ſubjects.]

5 [The mathematician contemplates only quantities that are meaſurable.]

The object of contemplation to the mathematician is not whatever is ſuſceptible of greater and leſs, but what is meaſurable; and mathematics is not the ſcience of magnitude, in its moſt abſtracted and general acceptation, but of magnitude which can be meaſured. It is, indeed, the SCIENCE OF MEASURE, and whatever is treated in the way of menſuration is treated mathematically. Now, in the diſcourſe of ordinary life and ordinary men, many things are called quantities which we cannot or *do not* meaſure. This is the caſe in the inſtances already given of the affections of the mind, pleaſure, pain, beauty, wiſdom, honour, &c. We do not ſay that they are incapable of meaſure; but we have not yet been able to meaſure them, nor do we think of meaſuring them when we ſpeak rationally and uſefully about them. We therefore do not conſider them mathematically; nor can we introduce mathematical preciſion into our diſcuſſions of theſe ſubjects till we can, and actually do, meaſure them. Perſons who are preciſe in their expreſſion will even avoid ſuch phraſes on theſe ſubjects as ſuppoſe, or ſtrictly expreſs, ſuch meaſurement. We ſhould be much embarraſſed how to anſwer the queſtion, How much pain does the toothache give you juſt now; and how much is it eaſier ſince yeſterday? Yet the anſwer (if we had a meaſure) would be as eaſy as to the queſtion, How many guineas did you win at cards? or how much land have you bought? Nay, though we ſay familiarly, "I know well how much ſuch a misfortune would affect you," and are underſtood when we ſay it, it would be aukward language to ſay, "I know well the quantity of your grief." It is in vain, therefore, to expect mathematical preciſion in our diſcourſe or conceptions of quantities in the moſt abſtracted ſenſe. Such preciſion is confined to quantity which may be and is meaſured (A). It is only

(A) To talk intelligibly of the quantity of a pain, we ſhould have ſome ſtandard by which to meaſure it; ſome known degree of it ſo well aſcertained, that all men, when talking of it, ſhould mean the ſame thing.—And we ſhould be able to compare other degrees of pain with this, ſo as to perceive diſtinctly, not only whether they exceed or fall ſhort of it, but alſo how much, or in what proportion; whether by an half, or a fifth, or tenth. *Reid.*

Quantity. only trifling with the imagination when we employ mathematical language on subjects which have not this property.

It will therefore be of some service in science to discriminate quantities in this view; to point out what are susceptible of measure, and what are not.

6
Measuring explained.

What is measuring? It is one of these two things: It is either finding out some known magnitude of the thing measured, which we can demonstrate to be equal to it; or to find a known magnitude of it, which being taken so many times shall be equal to it. The geometer measures the contents of a parabolic space when he exhibits a parallelogram of known dimensions, and demonstrates that this parallelogram is equal to the parabolic space. In like manner, he measures the solid contents of an infinitely extended hyperbolic spindle, when he exhibits a cone of known dimensions, and demonstrates that three of these cones are equal to the spindle.

In this process it will be found that he actually subdivides the quantity to be measured into parts of which it consists, and states these parts as actually making up the quantity, specifying each, and assigning its boundaries. He goes on with it, piece by piece, demonstrating the respective equalities as he goes along, till he has exhausted the figure, or considered all its parts.—When he measures by means of a submultiple, as when he shows the surface of a sphere to be equal to four of its great circles, he stops, after having demonstrated the equality of one of these circles to one part of the surface: then he demonstrates that there are other three parts, each of which is precisely equal to the one he has minutely considered. In this part of the process he expressly assigns the whole surface into its distinct portions, of which he demonstrates the equality.

But there is another kind of geometrical measurement which proceeds on a very different principle. The geometer conceives a certain individual portion of his figure, whether line, angle, surface, or solid, as known in respect to its dimensions. He conceives this to be lifted from its place, and again laid down on the *adjoining* part of the figure, and that it is equal to the part which it now covers; and therefore that this part together with the first is double of the first: he lifts it again, and lays it down on the next adjoining part, and affirms that this, added to the two former, make up a quantity triple of the first. He goes on in this way, making similar inferences, till he can demonstrate that he has in this manner covered the whole figure by twenty applications, and that his moveable figure will cover no more; and he affirms that the figure is twenty times the part employed.

This mode is precisely similar to the manner of practical measurement in common life: we apply a foot-rule successively to two lines, and find that 30 applications exhaust the one, while it requires 35 to exhaust the other. We say, therefore, that the one line is 30 and the other 35 feet long; and that these two lines are to each other in the ratio of 30 to 35. Having measured two shorter lines by a similar application of a stick of an inch long 30 times to the one and 35 times to the other, we say that the ratio of the two first lines is the same with that of the two last. Euclid has taken this method of demonstrating the fourth proposition of the first book of his celebrated elements.

7
Euclid's fourth proposition.

But all this process is a fiction of the mind, and it is the fiction of an impossibility. It is even *inconceivable*, that is, we cannot in imagination make this application of one figure to another; and we presume to say, that, if the elements of geometry cannot be demonstrated in some other way, the science has not that title to pure, abstract, and infallible knowledge, which is usually allowed it. We cannot *suppose* one of the triangles lifted and laid on the other, without supposing it something different from a triangle *in abstracto*. The *individuality* of such a triangle consists solely in its being in the precise place where it is, and in occupying *that* portion of space. If we could distinctly conceive otherwise, we should perceive that, when we have lifted the triangle from its place, and applied it to the other, it is gone from its former place, and that there is no longer a triangle *there*. This is inconceivable, and space has always been acknowledged to be immoveable. There is therefore some logical defect in Euclid's demonstration. We apprehend that he is labouring to demonstrate, or rather illustrate, a simple apprehension. This indeed is the utmost that can be done in any demonstration (see METAPHYSICS, n° 82.): but the mode by which he guides the mind to the apprehension of the truth of his fourth proposition is not consistent either with pure mathematics or with the laws of corporeal nature. The real process, as laid down by him, seems to be this. We suppose something different from the abstract triangle; some *thing* that, in conjunction with other properties, has the property of being triangular, with certain dimensions of two of its sides and the included angle. It has avowedly another property, not essential to, and not contained in, the abstract notion of a triangle, viz. mobility. We also suppose it permanent in shape and dimensions, or that although, *during* its motion, it does not occupy *the same space*, it continues, and all its parts, to occupy *an equal space*. In short, our conception is very mixed, and does not perceptibly differ from our conception of a triangular piece of matter, where the triangle is not the subject, but an adjunct, a quality. And when we suppose the application made, we are not in fact supposing two abstract triangles to coincide. This we cannot do with any thing like distinctness; for our distinct conception now is, not that of two triangles coinciding, but of one triangle being now exactly occupied by that moveable thing which formerly occupied the other. In short, it is a vulgar measurement, restricted by suppositions which are inadmissible in all *actual* measurements in the present universe, in which no moveable material thing is *known* to be permanent, either in shape or magnitude.

This is an undeniable consequence of the principle of universal gravitation, and the compressibility of every kind of tangible matter with which we are acquainted. Remove the brass rule but one inch from its place; its gravitation to the earth and to the rest of the universe is immediately changed, and its dimensions change of consequence. A change of temperature will produce a similar effect; and this is attended to and considered in all nice mensurations. We do the best we can to assure ourselves that our rule always occupies a sensibly equal space; and we must be contented with chances of error which we can neither perceive nor remove.

We might (were this a proper place) take notice of some other logical defects in the reasoning of this celebrated proposition: but they are beside our present purpose of explaining the different modes of mathemati-

Quantity. cal meaſurement, with the view of diſcovering that circumſtance in which they all agree, and which (if the only one) muſt therefore be the characteriſtic of menſuration.

8
The characteriſtic notion of menſuration.

We think that the only circumſtance in which all modes of menſuration agree, or the only notion that is found in them all, is, that the quantity is conceived as conſiſting of parts, diſtinguiſhable from each other, and ſeparated by aſſignable boundaries; ſo that they are at once conceived ſeparately and jointly. We venture to aſſert that no quantity is directly meaſured which we cannot conceive in this way, and that ſuch quantities only are the immediate objects of mathematical contemplation, and ſhould be diſtinguiſhed by a generic name. Let them be called MATHEMATICAL QUANTITIES. EXTENSION, DURATION, NUMBER, and PROPORTION, have this characteriſtic, and they are the only quantities which have it. Any perſon will be convinced of the firſt aſſertion by attending to his own thoughts when contemplating theſe notions. He will find that he conceives every one of them as made up of its own parts, which are diſtinguiſhable from each other, and have aſſignable boundaries, and that it is only in conſequence of involving this conception that they can be added to or ſubtracted from each other; that they can be multiplied, divided, and conceived in any proportion to each other.

He may perhaps find conſiderable difficulty in acquiring perfectly diſtinct notions of the menſurability, and the accuracy of the modes of menſuration. He will find that the way in which he meaſures duration is very ſimilar to that in which he meaſures ſpace or extenſion. He does not know, or does not attend to, any thing which hinders the braſs foot-rule in his hand from continuing to occupy equal ſpaces during his uſe of it, in meaſuring the diſtance of two bodies. In like manner he ſelects an event which nature or art can repeat continually, and in which the circumſtances which contribute to its accompliſhment are invariably the ſame, or their variations and their effects are inſenſible. He concludes that it will always occupy an equal portion of time for its accompliſhment, or always laſt an equal time. Then, obſerving that, during the event whoſe duration he wiſhes to meaſure, this ſtandard event is accompliſhed $29\frac{1}{2}$ times, and that it is repeated $365\frac{1}{4}$ times during the accompliſhment of another event, he affirms that the durations of theſe are in the ratio of $29\frac{1}{2}$ to $365\frac{1}{4}$. It is thus (and with the ſame logical defect as in the meaſuring a line by a braſs rod) that the aſtronomer meaſures the celeſtial revolutions by means of the rotation of the earth round its axis, or by the vibrations of a pendulum.

We are indebted for moſt of the preceding obſervations to Dr Reid, the celebrated author of the Inquiry into the Human Mind on the Principles of Common Senſe, and of the Eſſays on the intellectual and active Powers of Man. He has publiſhed a diſſertation on this ſubject in the 45th volume of the Philoſophical Tranſactions, nº 489, which we recommend to our philoſophical readers as a performance eminent for preciſion and acuteneſs. If we preſume to differ from him in any trivial circumſtance, it is with that deference and reſpect which is due to his talents and his worth.

9
Characters of mathematical quantity.

Dr Reid juſtly obſerves, that as nothing has proportion which has not either extenſion, duration, or number, the characters of mathematical quantity may be reſtricted to theſe three. He calls them PROPER quantities, and all others he calls IMPROPER. We believe that, in the utmoſt preciſion of the Engliſh language, this denomination is very appoſite, and that the word *quantity*, derived from *quantum*, always ſuppoſes meaſurement: But the word is frequently uſed in caſes where its original is not kept in view, and we uſe other words as ſynonymous with it, when all menſuration, whether poſſible or not, is out of our thoughts. According to practice, therefore, the *jus et norma loquendi*, there ſeems to be no impropriety in giving this name, in our language at leaſt, to whatever can be conceived as great or little. There is no impropriety in ſaying that the pain occaſioned by the ſtone is greater than that of the toothache; and when we ſearch for the category to which the aſſertion may be referred, we cannot find any other than quantity. We may be allowed therefore to ſay, with almoſt all our ſcientific countrymen, that every thing is conceivable in reſpect of quantity which we can think or ſpeak of as greater and leſs; and that this notion is the characteriſtic of quantity as a genus, while meaſureableneſs is the characteriſtic of mathematical quantity as a ſpecies.

10
Other quantities that cannot be conſidered mathematically.

But do we not meaſure many quantities, and conſider them mathematically, which have not this characteriſtic of being made up of their own diſtinguiſhable parts? What elſe is the employment of the mechanician, when ſpeaking of velocities, forces, attractions, repulſions, magnetic influence, chemical affinity, &c. &c.? Are not theſe mathematical ſciences? And if the preciſion and certainty of mathematics ariſe from the nature of their ſpecific object, are not all the claims of the mechanician and phyſical aſtronomer ill-founded pretenſions? Theſe queſtions require and deſerve a ſerious anſwer.

11
Velocity, force, denſity, how meaſured.

It is moſt certain that we conſider the notions which are expreſſed by theſe terms velocity, force, denſity, and the like, as ſuſceptible of meaſure, and we conſider them mathematically.

Some of theſe terms are nothing but names for relations of meaſurable quantity, and only require a little reflection to ſhow themſelves ſuch. VELOCITY is one of theſe. It is only a name expreſſing a relation between the ſpace deſcribed by a moving body and the time which elapſes during its deſcription. Certain moderate rates of motion are familiar to us. What greatly exceeds this, ſuch as the flight of a bird when compared with our walking, excites our attention, and this exceſs gets a name. A motion not ſo rapid as we are familiar with, or as we wiſh, alſo gets a name; becauſe in this the exceſs or defect may intereſt us. We wiſh for the flight of the hawk; we chide the tardy pace of our meſſenger: but it is ſcientific curioſity which firſt conſiders this relation as a *ſeparate* object of contemplation, and the philoſopher muſt have a name for it. He has not formed a new one, but makes uſe of a word of common language, whoſe natural meaning is the combination of a great ſpace with a ſhort time. Having once appropriated it, in his ſcientific vocabulary, to this very general uſe, it loſes with him its true ſignification. Tardity would have done juſt as well, though its true meaning is diametrically oppoſite; and there is no greater impropriety in ſaying the tardity of a cannon bullet than in ſaying the velocity of the hour-hand of a watch.

Velocity

Velocity is a quality or affection of motion, the notion of which includes the notions of ſpace and duration (two mathematical quantities), and no other. It does not therefore expreſs a mathematical quantity itſelf, but a relation, a combination of two mathematical quantities of different kinds; and as it is meaſurable in the quantities ſo combined, its meaſure muſt be a unit of its own kind, that is, an unit of ſpace *as combined* with an unit of time.

Density is another word of the ſame kind, expreſſing a combination of ſpace with number. *Denſæ arbores* means trees ſtanding at a ſmall diſtance from each other; and the word is uſed in the ſame ſenſe when we ſay that quickſilver is denſer than water. The expreſſion always ſuggeſts to the reflecting mind the notions of particles and their diſtances. We are indeed ſo habituated to complicated views of things, that we can ſee remote connections with aſtoniſhing rapidity; and a very few circumſtances are ſufficient for leading forward the mind in a train of inveſtigation. Common diſcourſe is a moſt wonderful inſtance of this. It is in this way that we ſay, that we found by weighing them that inflammable air had not the ſixth part of the denſity of common air. Suppoſing all matter to conſiſt of equal atoms equally heavy, and knowing that the weight of a bladder of air is the ſum of the weights of all the atoms, and alſo knowing that the *vicinity* of the atoms is in a certain proportion of the *number* contained in a given bulk, we affirm that common air is more than ſix times denſer than inflammable air; but this rapid deciſion is entirely the effect of habit, which makes us familiar with certain groups of conceptions, and we inſtantaneouſly diſtinguiſh them from others, and thus think and diſcourſe rationally. The Latin language employs the word *frequens* to expreſs both the combination of ſpace and number, and that of time and number.

There are perhaps a few more words which expreſs combinations of mathematical quantities of different kinds; and the correſponding ideas or notions are therefore proper and immediate ſubjects of mathematical diſcuſſion: But there are many words which are expreſſive of things, or at leaſt of notions, to which this way of conſidering them will not apply. All thoſe affections or qualities of external bodies, by which they are conceived to act on each other, are of this kind: Impulsive force, weight, centripetal and centrifugal force, magnetical, electrical, chemical attractions and repulsions; in ſhort, all that we conſider as the immediate cauſes of natural phenomena. Theſe we familiarly meaſure, and conſider mathematically.

12
Forces meaſured in the phenomena.

What was ſaid on this ſubject in the article Physics will give us clear conceptions of this proceſs of the mind. Theſe forces or cauſes are not immediate objects of contemplation, and are known only *by* and *in* the phenomena which we conſider as their effects. The phenomenon is not only the indication of the agency of any cauſe, and the characteriſtic of its kind, but the meaſure of its degree. The neceſſary circumſtances in this *train of human thought* are, 1ſt, The notion of the force as ſomething ſuſceptible of augmentation and diminution. 2d, The notion of an inſeparable connection of the force with the effect produced, and of every degree of the one with a correſponding degree of the other. From theſe is formed the notion that the phenomenon or effect is the proper meaſure of the force or cauſe. All this is ſtrictly logical.

But when we are conſidering theſe ſubjects mathematically, the immediate objects of our contemplation are not the forces which we are thus treating. It is not their relations which we perceive, and which we combine with ſuch complication of circumſtances and certainty of inference as are unknown in all other ſciences: by no means; they are the phenomena only, which are ſubjects of purely mathematical diſcuſſion. They are motions, which involve only the notions of ſpace and time; and when we have finiſhed an accurate mathematical inveſtigation, and make our affirmation concerning the forces, we are certain of its truth, becauſe we *ſuppoſe* the forces to have the proportions and relations, and no other, which we obſerve in the phenomena. Thus, after having demonſtrated, by the geometrical compariſon of the lines and angles and ſurfaces of an ellipſe, that the momentary deflection of the moon from the tangent of her orbit is the 3600th part of the ſimultaneous deflection of a ſtone from the tangent of its parabolic path, Newton affirms, that the force by which a particle of the moon is retained in her orbit is the 3600th part of the weight of a particle of the ſtone; and having farther ſhown, from fact and obſervation, that theſe momentary deflections are inverſely as the ſquares of the diſtances from the centre of the earth, he affirms, that all this is produced by a force which varies its intenſity in this manner.

Now all this inveſtigation proceeds on the two ſuppoſitions mentioned above, and the meaſures of the forces are in fact the meaſures of the phenomena. The whole of phyſical aſtronomy, and indeed the whole of mechanical philoſophy, might be taught and underſtood, without ever introducing the word force, or the notion which it is ſuppoſed to expreſs: for our mathematical reaſonings are really about the phenomena, which are ſubjects purely mathematical.

The preciſion, therefore, that we preſume to affirm to attend theſe inveſtigations, ariſes entirely from the meaſurable nature of the quantities which are the real objects of our contemplation, and the ſuitableneſs and propriety of the meaſures which we adopt in our compariſons.

Since, then, the phenomena are the *immediate* ſubjects of our diſcuſſion, and the operating powers are only inferences from the phenomena conſidered as effects, the quantity aſcribed to them muſt alſo be an inference from the quantity of the effect, or of ſome circumſtance in the effect. The meaſure, therefore, of the cauſe, or natural power or force, cannot be one of its own parts; for the whole and the part are equally unperceived by us. Our meaſure, therefore, muſt be a meaſure of ſome intereſting part, or of the only intereſting part of the phenomenon. It is therefore in a manner arbitrary, and depends chiefly on the intereſt we take in the phenomenon. It muſt, however, be ſettled with preciſion, ſo that all men in uſing it may mean the ſame thing. It muſt be ſettled, therefore, by the deſcription of that part or circumſtance of the phenomenon which is characteriſtic of the natural power. This deſcription is the *definition* of the meaſure.

13
Meaſure of centripetal force

Thus Newton aſſumes as his meaſure of the centripetal force, the momentary deviation from uniform rectilineal motion. Others, and ſometimes Newton himſelf,

himſelf, aſſumes the momentary change of velocity, which again is meaſured by *twice this deviation.* Theſe meaſures, being thus ſelected, are always proper in a mathematical ſenſe; and if ſtrictly adhered to, can never lead us into any paralogiſm. They may, however, be phyſically wrong: there may not be that indiſſoluble connection between the phenomenon and the ſuppoſed cauſe. But this is no mathematical error, nor does it invalidate any of our mathematical inferences: it only makes them uſeleſs for explaining the phenomenon by the principle which we adopted; but it prepares a modification of the phenomenon for ſome more fortunate application of phyſical principles.

14 [Re]quiſites [of ſ]uch [me]aſures.

All that can be deſired in the definitions or deſcriptions of theſe meaſures is, that they may not deviate from the ordinary uſe of the terms, becauſe this would always create confuſion, and occaſion miſtakes. Dr Reid has given an example of an impropriety of this kind, which has been the ſubject of much debate among the writers on natural philoſophy. We mean the meaſure of the force inherent in a body in motion. Deſcartes, and all the writers of his time, aſſumed the velocity produced in a body as the meaſure of the force which produces it; and obſerving that a body, in conſequence of its being in motion, produces changes in the ſtate or motion of other bodies, and that theſe changes are in the proportion of the velocity of the changing body, they aſſerted that there is in a moving body a VIS INSITA, an INHERENT FORCE, and that this is proportional to its velocity; ſaying that its force is twice or thrice as great, when it moves twice or thrice as faſt at one time as at another. But Leibnitz obſerved, that a body which moves twice as faſt, riſes four times as high, againſt the uniform action of gravity; that it penetrates four times as deep into a piece of uniform clay; that it bends four times as many ſprings, or a ſpring four times as ſtrong, to the ſame degree; and produces a great many effects which are four times greater than thoſe produced by a body which has half the initial velocity. If the velocity be triple, quadruple, &c. the effects are nine times, 16 times, &c. greater; and, in ſhort, are proportional, not to the velocity, but to its ſquare. This obſervation had been made before by Dr Hooke, who has enumerated a prodigious variety of important caſes in which this proportion of effect is obſerved. Leibnitz, therefore, affirmed, that the force inherent in a moving body is proportional to the ſquare of the velocity.

15 [Co]ntrover[ſy] between [the] Carteſi[ans] and [Lei]bnitzi[ans] on this [ſub]ject.

It is evident that a body, moving with the ſame velocity, has the ſame inherent force, whether this be employed to move another body, to bend ſprings, to riſe in oppoſition to gravity, or to penetrate a maſs of ſoft matter. Therefore theſe meaſures, which are ſo widely different, while each is agreeable to a numerous claſs of facts, are not meaſures of this ſomething inherent in the moving body which we call its force, but are the meaſures of its exertions when modified according to the circumſtances of the caſe; or, to ſpeak ſtill more cautiouſly and ſecurely, they are the meaſures of certain claſſes of phenomena conſequent on the action of a moving body. It is in vain, therefore, to attempt to ſupport either of them by a demonſtration. The meaſure itſelf is nothing but a definition. The Carteſian calls that a double force which produces a double velocity in the body on which it acts. The Leibnitzian calls that a quadruple force which makes a quadruple penetration. The reaſonings of both in the demonſtration of a propoſition in dynamics may be the ſame, as alſo the reſult, though expreſſed in different numbers.

But the two meaſures are far from being equally proper: for the Leibnitzian meaſure obliges us to do continual violence to the common uſe of words. When two bodies moving in oppoſite directions meet, ſtrike each other, and ſtop, all men will ſay that their forces are equal, becauſe they have the beſt teſt of equality which we can deviſe. Or when two bodies in motion ſtrike the parts of a machine, ſuch as the oppoſite arms of a lever, and are thus brought completely to reſt, we and all men will pronounce their mutual energies by the intervention of the machine to be equal. Now, in all theſe caſes, it is well known that a perfect equality is found in the products of the quantities of matter and velocity. Thus a ball of two pounds, moving with the velocity of four feet in a ſecond, will ſtop a ball of eight pounds moving with the velocity of one foot per ſecond. But the followers of Leibnitz ſay, that the force of the firſt ball is four times that of the ſecond.

All parties are agreed in calling gravity a uniform or invariable accelerating force; and the definition which they give of ſuch a force is, that it always produces the ſame acceleration, that is, equal accelerations in equal times, and *therefore* produces augmentations of velocity proportionable to the times in which they are produced. The only effect aſcribed to this force, and conſequently the only thing which indicates, characteriſes, and meaſures it, is the augmentation of velocity. What is this velocity, conſidered not merely as a mathematical term, but as a phenomenon, as an event, a production by the operation of a natural cauſe? It cannot be conceived any other way than as a *determination* to move on for ever at a certain rate, if nothing ſhall change it. We cannot conceive this very clearly. We feel ourſelves forced to animate, as it were, the body, and give it not only a will and intention to move in this manner, but a real exertion of ſome faculty in conſequence of this determination of mind. We are conſcious of ſuch a train of operations in ourſelves; and the laſt ſtep of this train is the exertion or energy of ſome natural *faculty*, which we, in the utmoſt propriety of language, call force. By ſuch analogical conception, we ſuppoſe a ſomething, an energy, inherent in the moving body; and its only office is the production and continuation of this motion, as in our own caſe. Scientific curioſity was among our lateſt wants, and language was formed long before its appearance: as we formed analogical conceptions, we contented ourſelves with the words already familiar to us, and to this ſomething we gave the name FORCE, which expreſſed that energy in ourſelves which bears ſome reſemblance (in office at leaſt) to the determination of a body to move on at a certain rate. This ſort of allegory pervades the whole of our conceptions of natural operations, and we can hardly think or ſpeak of any operation without a language, which ſuppoſes the animation of matter. And, in the preſent caſe, there are ſo many points of reſemblance between the effects of our exertions and the operations of nature, that the language is moſt expreſſive, and has the ſtrongeſt appearance of propriety. By exerting our force, we not only move and keep in motion, but we move other bodies. Juſt ſo a ball not only moves,

Quantity. but puts other bodies in motion, or penetrates them, &c.—This is the origin of that conception which so forcibly obtrudes itself into our thoughts, that there is inherent in a moving body a force by which it produces changes in other bodies. No such thing appears in the same body if it be not in motion. We therefore conclude, that it is the production of the moving force, whatever that has been. If so, it must be conceived as proportional to its producing cause. Now this force, thus produced or exerted in the moving body, is only another way of conceiving that determination which we call velocity, when it is conceived as a natural event. We can form no other notion of it. The *vis insita*, the determination to move at a certain rate, and the velocity, are one and the same thing, considered in different relations.

16 Vis insita.

Therefore the *vis insita corpori moventi*, the determination to move at a certain rate, and the velocity, should have one and the same measure, or any one of them may be taken for the measure of the other. The velocity being an object of perception, is therefore a proper measure of the inherent force; and the propriety is more evident by the perfect agreement of this use of the words with common language. For we conceive and express the action of gravity as uniform, when we think and say that its effects are proportional to the times of its action. Now all agree, that the velocity produced by gravity is proportional to the time of its action. And thus the measure of force, in reference to its producing cause, perfectly agrees with its measure, independent of this consideration.

But this agreement is totally lost in the Leibnitzian doctrine; for the body which has fallen four times as far, and has sustained the action of gravity twice as long, is said to have four times the force.

The quaintness and continual paradox of expression which this measure of inherent force leads us into, would have quickly exploded it, had it not been that its chief abettors were leagued in a keen and acrimonious warfare with the British mathematicians who supported the claim of Sir Isaac Newton to the invention of fluxions. They rejoiced to find in the elegant writings of Huyghens a physical principle of great extent, such as this is, which could be set in comparison with some of the wonderful discoveries in Newton's Principia. The fact, that in the mutual actions of bodies on each other the products of the masses and the squares of the velocities remain always the same (which they call the *conservatio virium vivarum)*, is of almost universal extent; and the knowledge of it enabled them to give ready and elegant solutions of the most abstruse and intricate problem, by which they acquired a great and deserved celebrity. Dr Robert Hooke, whose observation hardly any thing escaped, was the first (long before Huyghens) who remarked *, that in all the cases of the gradual production and extinction of motion, the sensible phenomenon is proportional to the square of the produced or extinguished velocity.

17 Conservatio virium vivarum.

* *Micographia, vis restitutiva,* &c. in his Posthumous Works.

John Bernoulli brought all these facts together, and systematized them according to the principle advanced by Huyghens in his treatise on the centre of oscillation. He and Daniel Bernoulli gave most beautiful specimens of the prodigious use of this principle for the solution of difficult physical problems in their dissertations on the motion and impulse of fluids, and on the communication of motion. It was however very early objected to them (we think by Marquis Poleni), that in the collision of bodies perfectly hard there was no such *conservatio virium vivarum;* and that, in this case, the forces must be acknowledged to be proportional to the velocities. The objections were unanswerable.—But John Bernoulli evaded their force, by affirming that there were and could be no bodies perfectly hard. This was the origin of another celebrated doctrine, on which Leibnitz greatly plumed himself, THE LAW OF CONTINUITY, viz. that nothing is observed to change abruptly, or *per saltum*. But no one will pretend to say that a perfectly hard body is an inconceivable thing; on the contrary, all will allow that softness and compressibility are adjunct ideas, and not in the least necessary to the conception of a particle of matter, nay totally incompatible with our notion of an ultimate atom.

18 Law of continuity.

Sir Isaac Newton never could be provoked to engage in this dispute. He always considered it as a wilful abuse of words, and unworthy of his attention. He guarded against all possibility of cavil, by giving the most precise and perspicuous definitions of those measures of forces, and all other quantities which he had occasion to consider, and by carefully adhering to them. And in one proposition of about 20 lines, viz. the 39th of the 1st book of the Principia, he explained every phenomenon adduced in support of the Leibnitzian doctrine, showing them to be immediate consequences of the action of a force measured by the velocity which it produces or extinguishes. There it appears that the heights to which bodies will rise in opposition to the uniform action of gravity are as the squares of the initial velocities: So are the depths to which they will penetrate uniformly resisting matter: So is the number of equal springs which they will bend to the same degree, &c. &c. &c. We have had frequent occasion to mention this proposition as the most extensively useful of all Newton's discoveries. It is this which gives the immediate application of mechanical principles to the explanation of natural phenomena. It is incessantly employed in every problem by the very persons who hold by the other measure of forces, although such conduct is virtually giving up that measure. They all adopt, in every investigation, the two theorems $f\dot{t}=\dot{v}$, and $f\dot{s}=v\dot{v}$; both of which suppose an accelerating force f proportional to the velocity v which it produces by its uniform action during the time t, and the theorem $\int f\dot{s}=v^2$ is the 39th 1. Princip. and is the *conservatio virium vivarum*.

19 Great superiority of Newton.

This famous dispute (the only one in the circle of mathematical science) has led us somewhat aside. But we have little more to remark with respect to measurable quantity. We cannot say what varieties of quantity are susceptible of strict measure, or that it is impossible to give accurate measures of every thing susceptible of augmentation and diminution. We affirm, however, with confidence, that pain, pleasure, joy, &c. are not made up of their own parts, which can be contemplated separately: but they may chance to be associated by nature with something that is measurable; and we may one day be able to assign their degrees with as much precision as we now ascertain the degrees of warmth by the expansion of the fluid in the thermometer. There is one sense in which they may all be

Quantity. be meaſured, viz. numerically, as Newton meaſures denſity, *vis motrix*, &c. We can conceive the pain of each of a dozen men to be the ſame. Then it is evident that the pain of eight of theſe men is to that of the remaining four as two to one; but from ſuch menſuration we do not foreſee any benefit likely to ariſe.

Quantity, in grammar, an affection of a ſyllable, whereby its meaſure, or the time wherein it is pronounced, is aſcertained; or that which determines the ſyllable to be long or ſhort.

Quantity is alſo the object of proſody, and diſtinguiſhes verſe from proſe; and the economy and arrangement of quantities, that is, the diſtribution of long and ſhort ſyllables, makes what we call the *number*. See Poetry, Part III.

The quantities are uſed to be diſtinguiſhed, among grammarians, by the characters ˘, ſhort, as pĕr; and ‒, long, as rōs. There is alſo a common, variable, or dubious quantity; that is, ſyllables that are one time taken for ſhort ones, and at another time for long ones; as the firſt ſyllable in *Atlas*, *patres*, &c.

QUARANTINE, is a trial which ſhips muſt undergo when ſuſpected of a peſtilential infection. It may be ordered by the king, with advice of the privy-council, at ſuch times, and under ſuch regulations, as he judges proper. Ships ordered on quarantine muſt repair to the place appointed, and muſt continue there during the time preſcribed (generally ſix weeks); and muſt have no intercourſe with the ſhore, except for neceſſary proviſions, which are conveyed with every poſſible precaution. When the time is expired, and the goods opened and expoſed to the air as directed, if there be no appearance of infection they are admitted to port.

Ships infected with the peſtilence muſt proceed to St Helen's Pool in the Scilly iſlands, and give notice of their ſituation to the cuſtomhouſe officers, and wait till the king's pleaſure be known.

Perſons giving falſe information to avoid performing quarantine, or refuſing to go to the place appointed, or eſcaping, alſo officers appointed to ſee quarantine performed, deſerting their office, neglecting their duty, or giving a falſe certificate, ſuffer death as felons.

Goods from Turkey, or the Levant, may not be landed without licenſe from the king, or certificate that they have been landed and aired at ſome foreign port. See Plague.

QUARLES (Francis), the ſon of James Quarles clerk to the board of green cloth and purveyor to queen Eliſabeth, was born in 1592. He was educated at Cambridge; became a member of Lincoln's inn; and was for ſome time cup-bearer to the Queen of Bohemia, and chronologer to the city of London. It was probably on the ruin of her affairs that he went to Ireland as ſecretary to archbiſhop Uſher; but the troubles in that kingdom forcing him to return, and not finding affairs more at peace in England, ſome diſquiets he met with were thought to have haſtened his death, which happened in 1644. His works both in proſe and verſe are numerous, and were formerly in great eſteem, particularly his Divine Emblems: but the obſolete quaintneſs of his ſtyle has cauſed them to fall into neglect, excepting among particular claſſes of readers.

Headley's Select Beauties of Ancient English Poetry. "The memory of Quarles, ſays a late author, has been branded with more than common abuſe, and he ſeems to have been cenſured merely from the want of being read. If his poetry failed to gain him friends and readers, his piety ſhould at leaſt have ſecured him peace and goodwill. He too often, no doubt, miſtook the enthuſiaſm of devotion for the inſpiration of fancy; to mix the waters of Jordan and Helicon in the ſame cup, was reſerved for the hand of Milton; and for him, and him only, to find the bays of Mount Olivet equally verdant with thoſe of Parnaſſus. Yet, as the effuſions of a real poetical mind, however thwarted by untowardneſs of ſubject, will be ſeldom rendered totally abortive, we find in Quarles original imagery, ſtriking ſentiment, fertility of expreſſion, and happy combinations; together with a compreſſion of ſtyle that merits the obſervation of the writers of verſe. Groſs deficiencies of judgment, and the infelicity of his ſubjects, concurred in ruining him. Perhaps no circumſtance whatever can give a more complete idea of Quarles's degradation than a late edition of his Emblems; the following paſſage is extracted from the preface: 'Mr Francis Quarles, the author of the Emblems that go under his name, was a man of the moſt exemplary piety, and had a deep inſight into the myſteries of our holy religion. But, for all that, the book itſelf is written in ſo old a language, that many parts of it are ſcarce intelligible in the preſent age; many of his phraſes are ſo affected, that no perſon, who has any taſte for reading, can peruſe them with the leaſt degree of pleaſure; many of his expreſſions are harſh, and ſometimes whole lines are included in a parentheſis, by which the mind of the reader is diverted from the principal object. His Latin mottos under each cut can be of no ſervice to an ordinary reader, becauſe he cannot underſtand them. In order, therefore, to accommodate the public with an edition of Quarles's Emblems properly moderniſed, this work was undertaken.' Such an exhibition of Quarles is chaining Columbus to an oar, or making John Duke of Marlborough a train-band corporal."

Quarries.

QUARRIES, a name commonly given to a moſt extraordinary cavern under the city of Paris, the exiſtence of which is known to few even of the inhabitants, and many of thoſe who have heard of it conſider the whole as an idle ſtory. Mr Thomas White, however, member of the Royal Medical Society of Edinburgh, &c. who viſited it in 1784, puts the matter beyond a doubt; having, with many others, obtained leave (which is very cautiouſly granted) to inſpect it, having guides and torches with them. He gives the following account of it in the ſecond volume of the Mancheſter Tranſactions. "At the entrance by the *Obſervatoire Royal*, the path is narrow for a conſiderable way; but ſoon we entered large and ſpacious ſtreets, all marked with names, the ſame as in the city; different advertiſements and bills were found, as we proceeded, paſted on the walls, ſo that it had every appearance of a large town ſwallowed up in the earth.

"The general height of the roof is about 9 or 10 feet; but in ſome parts not leſs than 30 and even 40. In many places there is a liquor continually dropping from it, which congeals immediately, and forms a ſpecies of tranſparent ſtone, but not ſo fine and clear as rock cryſtal. As we continued our peregrination, we thought ourſelves in no ſmall danger from the roof, which we found but indifferently propped in ſome places with wood much decayed. Under the houſes, and many of the ſtreets, however, it ſeemed to be tolerably ſecured by immenſe ſtones ſet in mortar; in other parts, where

there are only fields or gardens above, it was totally unſupported for a conſiderable ſpace, the roof being perfectly level, or a plane piece of rock. After traverſing about two miles, we again deſcended about 20 ſteps, and here found ſome workmen in a very cold and damp place, propping up a moſt dangerous part, which they were fearful would give way every moment. The path here is not more than three feet in width, and the roof ſo low, that we were obliged to ſtoop conſiderably.

"On walking ſome little diſtance farther, we entered into a kind of ſaloon cut out of the rock, and ſaid to be exactly under the *Eglise de St Jacques*. This was illuminated with great taſte, occaſioned an agreeable ſurpriſe, and made us all ample amends for the danger and difficulty we had juſt before gone through. At one end was a repreſentation in miniature of ſome of the principal forts in the Indies, with the fortifications, draw-bridges, &c. Cannons were planted with a couple of ſoldiers to each ready to fire. Centinels were placed in different parts of the garriſon, particularly before the governor's houſe; and a regiment of armed men was drawn up in another place with their general in the front. The whole was made up of a kind of clay which the place affords, was ingeniouſly contrived, and the light that was thrown upon it gave it a very pretty effect.

"On the other ſide of this hall was a long table ſet out with cold tongues, bread, and butter, and ſome of the beſt Burgundy I every drank. Now every thing was hilarity and mirth; our fears were entirely diſpelled, and the danger we dreaded the moment before was now no longer thought of. In ſhort, we were all in good ſpirits again, and proceeded on our journey about two miles farther, when our guides judged it prudent for us to aſcend, as we were then got to the ſteps which lead up to the town. We here found ourſelves ſafe at the *Val de Grace*, near to the Engliſh Benedictine convent, without the leaſt accident having happened to any one of the party. We imagined we had walked about two French leagues, and were abſent from the ſurface of the earth betwixt four and five hours.

"There were formerly ſeveral openings into the quarries, but the two I have mentioned, viz. the *Obſervatory* and the *Val de Grace*, are, I believe, the only ones left; and theſe the inſpectors keep conſtantly locked, and rarely open them, except to ſtrangers particularly introduced, and to workmen who are always employed in ſome part by the king. The police thought it a neceſſary precaution to ſecure all the entrances into this cavern, from its having been formerly inhabited by a famous gang of robbers, who infeſted the country for many miles round the city of Paris.

"As to the origin of this quarry, I could not, on the ſtricteſt inquiry, learn any thing ſatisfactory; and the only account I know publiſhed is the following contained in the *Tableaux de Paris, nouvelle edition, tom premier, chapitre 5me, page 12me.*

"For the firſt building of Paris it was neceſſary to get the ſtone in the environs; and the conſumption of it was very conſiderable. As Paris was enlarged, the ſuburbs were inſenſibly built on the ancient quarries, ſo that all that you ſee without is eſſentially wanting in the earth for the foundation of the city: hence proceed the frightful cavities which are at this time found under the houſes in ſeveral quarters. They ſtand upon abyſſes. It would not require a very violent ſhock to throw back the ſtones to the place from whence they have been raiſed with ſo much difficulty. Eight men being ſwallowed up in a gulph 150 feet deep, and ſome other leſs known accidents, excited at length the vigilance of the police and the government, and, in fact, the buildings of ſeveral quarters have been privately propped up; and by this means a ſupport given to theſe obſcure ſubterraneous places which they before wanted.

"All the ſuburbs of St James's, Harp-ſtreet, and even the ſtreet of Tournon, ſtand upon the ancient quarries; and pillars have been erected to ſupport the weight of the houſes. What a ſubject for reflections, in conſidering this great city formed and ſupported by means abſolutely contrary! Theſe towers, theſe ſteeples, the arched roofs of theſe temples, are ſo many ſigns to tell the eye that what we now ſee in the air is wanting under our feet."

QUARRY, a place under ground, out of which are got marble, freeſtone, ſlate, limeſtone, or other matters proper for building. See STRATA.

Some limeſtone quarries in Fife are highly worthy the attention of the curious, on account of an amazing mixture of ſea-bodies found in them. One of this kind was opened about the year 1759, at a farm called *Enderteel*, in the neighbourhood of Kirkaldy, belonging to General St Clair.

The flakes of the ſtone, which are of unequal thickneſs, moſt of them from eight to ten inches, lie horizontally, dipping towards the ſea. Each of theſe flakes, when broken, preſents to our view an amazing collection of petrified ſea bodies, as the bones of fiſhes, ſtalks of ſea-weed, vaſt quantities of ſhells, ſuch as are commonly found on thoſe coaſts, beſides ſeveral others of very uncommon figures. In ſome places the ſhells are ſo numerous, that little elſe is to be ſeen but prodigious cluſters or concretions of them. In the uppermoſt ſtratum the ſhells are ſo entire, that the outer cruſt or plate may be ſcraped off with the finger; and the ſtalks of the ſea-weed have a darkiſh colour, not that gloſſy whiteneſs which they have in the heart of the quarry. The ſmalleſt rays or veins of the ſhells are deeply indented on the ſtone, like the impreſſion of a ſeal upon wax. In ſhort, no ſpot at the bottom of the ocean could exhibit a greater quantity of ſea-bodies than are to be found in this ſolid rock; for we have the ſkeletons of ſeveral fiſhes, the *antennæ* or feelers of lobſters, the roots and ſtalks of ſea-weeds, with the very *capſulæ* which contain the ſeed. The place where all theſe curioſities are found is on an eminence about an Engliſh mile from the ſea; and as the ground is pretty ſteep the whole way, it may be 200 feet higher at leaſt.

There are two or three things to be remarked here. 1. That among all the bodies we have mentioned, there are none but what are ſpecifically heavier than water. This holds ſo conſtantly true, that the ſea-weed, which floats in water when the plant is entire, has been ſtripped of the broad leaves, which make it buoyant, before it has been lodged here. 2. The ſhells have been all empty; for the double ones, as thoſe of the flat kind, are always found ſingle, or with one ſide only. 3. The rock ſeems to have been gradually deſerted

Quarry || Quarter

serted by the sea, and for a long time, washed with the tides; for the upper surface is all eaten, and hollowed in many places like an honey-comb, just as we observe in flat rocks exposed every tide to the access and recess of the waters. See the article SEA.

QUARRY, or *Quarrel*, among glaziers, a pane of glass cut in a diamond form.

Quarries are of two kinds, square and long; each of which are of different sizes, expressed by the number of the pieces that make a foot of glass, viz. eighths, tenths, eighteenths, and twentieths: but all the sizes are cut to the same angles, the acute angle in the square quarrels being 77° 19′, and 67° 21′ in the long ones.

QUARRY, among hunters, is sometimes used for a part of the entrails of the beast taken, given by way of reward to the hounds.

QUARRY, in falconry, is the game which the hawk is in pursuit of, or has killed.

QUARTAN, a measure containing the fourth part of some other measure.

QUARTAN, a species of intermitting fever. See MEDICINE, n° 153, 158, and 159.

QUARTATION, is an operation by which the quantity of one thing is made equal to a fourth part of the quantity of another thing. Thus when gold allayed with silver is to be parted, we are obliged to facilitate the action of the aquafortis, by reducing the quantity of the former of these metals to one fourth part of the whole mass; which is done by sufficiently increasing the quantity of the silver, if it be necessary. This operation is called *quartation*, and is preparatory to the parting; and even many authors extend this name to the operation of parting. See the article PARTING.

QUARTER, the fourth part of any thing, the fractional expression for which is $\frac{1}{4}$.

QUARTER, in weights, is generally used for the fourth part of an hundred weight avoirdupois, or 28 lb.

Used as the name of a dry measure, *quarter* is the fourth part of a ton in weight, or eight bushels.

QUARTER, a term in the manege. To work from quarter to quarter, is to ride a horse three times in upon the first of the four lines of a square; then changing your hand, to ride him three times upon the second: and so to the third and fourth; always changing hands, and observing the same order.

QUARTERS, with respect to the parts of a horse, is used in various senses: thus the shoulders and fore-legs are called the *fore-quarters*, and the hips and hinder-legs the *hind-quarters*. The *quarters* of a horse's foot are the sides of the coffin, comprehending between the toe and the heel: the *inner* quarters are those opposite to one another, facing from one foot to the other; and these are always weaker than the *outside* quarters, which lie on the external sides of the coffin. *False quarters*, are a cleft in the horn of a horse's hoof, extending from the coronet to the shoe. A horse is said to be *quarter-cast*, when for any disorder in the coffin we are obliged to cut one of the quarters of the hoof.

QUARTER, in astronomy, the fourth part of the moon's period: thus, from the new moon to the quadrature is the first quarter; from this to full moon, the second quarter, &c.

QUARTER, in heraldry, is applied to the parts or members of the first division of a coat that is quartered, or divided into four quarters.

Quarter.

Franc QUARTER, in heraldry, is a quarter single or alone; which is to possess one fourth part of the field. It makes one of the honourable ordinaries of a coat.

QUARTER of a Ship, that part of the ship's side which lies towards the stern; or which is comprehended between the aftmost end of the main chains and the sides of the stern, where it is terminated by the quarter-pieces.

Although the lines by which the quarter and bow of a ship, with respect to her length, are only imaginary, yet experience appears sufficiently to have ascertained their limits: so that if we were to divide the ship's sides into five equal portions, the names of each space would be readily enough expressed. Thus the first, from the stern, would be the quarter; the second, abaft the midships; the third, the midships; the fourth, before the midships; and the fifth, the bow. Whether these divisions, which in reality are somewhat arbitrary, are altogether improper, may be readily discovered by referring to the mutual situation or approach of two adjacent vessels. The enemy boarded us on the larboard side! Whereabouts? Abaft the midships, before the midships, &c.

Plate CCCCXXVII. n° 1. represents a geometrical elevation of a quarter of a 74 gun ship. A the keel, with *a* the false keel beneath it. B the stern-post. DD the quarter-gallery, with its ballustrades and windows. EE the quarter-pieces, which limit and form the outlines of the stern. F the taffarel, or upper pieces of the stern. FG the profile of the stern, with its galleries. H the gun-ports of the lower-deck; *h* the gun-ports of the upper and quarter-deck. I the after-part of the mizen-channel. K the wing-transom. KG the lower counter. LB the station of the deck-transom. LQ the after-part of the main-wale. DR the after-part of the channel-wale, parallel to the main-wale. SU the sheer-rail, parallel to both wales. T *t* the rudder. A *t* F the rake of the stern. P *i i* the drift-rails. TU the after-part of the load *water-line*; *k k l* the curve of the several decks corresponding to those represented in the head. See the article HEAD.

As the marks, by which vessels of different constructions are distinguished from each other, are generally more conspicuous on the stern or quarter than any other part, we have represented some of the quarters, which assume the most different shapes, and form the greatest contrast with each other. N° 2. shows the stern and quarter of a Dutch flight. N° 3. the stern and quarter of a cat. N° 4. is the stern and quarter of a common galley. N° 5. exhibits the quarter of a first-rate galley, otherwise called a *galleasse*. N° 6. the quarter of a Dutch dogger, or galliot. N° 7. represents the stern and quarter of a sloop of war.

The quarters of all other ships have a near affinity to those above exhibited. Thus all ships of the line, and East-Indiamen, are formed with a quarter little differing from the principal figure in this plate. Xebecs have quarters nearly resembling those of galeasses, only somewhat higher. Hagboats and pinks approach the figure of *cats*, the former being a little broader in the stern, and the latter a little narrower; and the sterns and quarters of cats seem to be derived from those of fly-

boats.

Quarter. boats. The sterns of Dutch doggers and galliots are indeed singular, and like those of no other modern vessel: they have nevertheless a great resemblance to the ships of the ancient Grecians, as represented in medals and other monuments of antiquity.

On the QUARTER, may be defined an arch of the horizon, contained between the line prolonged from the ship's stern and any distant object, as land, ships, &c. Thus if the ship's keel lies on an east and west line, the stern being westward, any distant object perceived on the north-west or south-west, is said to be on the larboard or starboard quarter.

QUARTER-*Bill*, a roll, or list, containing the different stations, to which all the officers and crew of the ship are quartered in the time of battle, and the names of all the persons appointed to those stations. See QUARTERS.

QUARTER-*Master*, is an officer, generally a lieutenant, whose principal business is to look after the quarters of the soldiers, their clothing, bread, ammunition, firing, &c. Every regiment of foot and artillery has a quarter-master, and every troop of horse one, who are only warrant-officers, except in the Blues.

QUARTER-*Master-General*, is a considerable officer in the army; and should be a man of great judgment and experience, and well skilled in geography. His duty is to mark the marches and encampments of an army: he should know the country perfectly well, with its rivers, plains, marshes, woods, mountains, defiles, passages, &c. even to the smallest brook. Prior to a march, he receives the order and route from the commanding general, and appoints a place for the quarter-masters of the army to meet him next morning, with whom he marches to the next camp; where being come, and having viewed the ground, he marks out to the regimental quarter-masters the ground allowed each regiment for their camp: he chooses the head-quarters, and appoints the villages for the generals of the army's quarters: he appoints a proper place for the encampment of the train of artillery: he conducts foraging parties, as likewise the troops to cover them against assaults, and has a share in regulating the winter-quarters and cantonments.

QUARTER *Netting*, a sort of net-work, extended along the rails on the upper part of a ship's quarter. In a ship of war these are always double, being supported by iron cranes, placed at proper distances. The interval is sometimes filled with cork, or old sails; but chiefly with the hammocks of the sailors, so as to form a parapet to prevent the execution of the enemy's small arms in battle.

Blackstone's Comment. vol IV. p. 271. QUARTER-*Sessions*, a general court held quarterly by the justices of peace of each county. This court is appointed by stat. 2 Hen. V. c. 4. to be in the first week after Michaelmas-day; the first week after the Epiphany; the first week after the close of Easter; and in the week after the translation of Saint Thomas a Becket, or the 7th of July. This court is held before two or more justices of the peace, one of whom must be of the *quorum*. The jurisdiction of this court by 34 Ed. III. c. 1. extends to the trying and determining of all felonies and trespasses whatsoever, though they seldom, if ever, try any greater offence than small felonies within the benefit of clergy, their commission providing, that if any case of difficulty arises, they shall not proceed to judgment, but in the presence of one of the justices of the courts of king's bench or common pleas, or one of the judges of assize. And therefore murderers and other capital felons are usually remitted for a more solemn trial to the assizes. They cannot also try any new-created offence, without express power given them by the statute which creates it. But there are many offences, and particular matters, which by particular statutes belong properly to this jurisdiction, and ought to be prosecuted in this court; as, the smaller misdemeanors against the public or commonwealth, not amounting to felony, and especially offences relating to the game, highways, alehouses, bastard children, the settlement and provision for the poor, vagrants, servants wages, apprentices, and popish recusants. Some of these are proceeded upon by indictment, and others in a summary way by motion and order thereupon; which order may, for the most part, unless guarded against by particular statutes, be removed into the court of king's bench, by writ of *certiorari facias*, and be there either quashed or confirmed. The records or rolls of the sessions are committed to the custody of a special officer, denominated the *custos rotulorum*. In most corporation towns there are quarter-sessions kept before justices of their own, within their respective limits, which have exactly the same authority as the general quarter-sessions of the county, except in very few instances: one of the most considerable of which is the matter of appeals from orders of removal of the poor, which, though they be from the orders of corporation justices, must be to the sessions of the county, by 8 and 9 Will. III. c. 30. In both corporations and counties at large, there is sometimes kept a special or petty session, by a few justices, for dispatching smaller business in the neighbourhood between the times of the general sessions, as for licensing alehouses, passing the accounts of parish-officers, and the like.

QUARTER-*Staff*, a long staff borne by foresters, park-keepers, &c. as a badge of their office, and occasionally used as a weapon.

QUARTERS, a name given at sea to the several stations where the officers and crew of a ship of war are posted in action. See *Naval Tactics*.

The number of men appointed to manage the artillery is always in proportion to the nature of the guns, and the number and condition of the ship's crew. They are, in general, as follow, when the ship is well manned, so as to fight both sides at once occasionally:

Pounder.	No. of men.	Pounder.	No. of men.
To a 42	15	To a 9	6
32	13	6	5
24	11	4	4
18	9	3	3
12	7		

This number, to which is often added a boy to bring powder to every gun, may be occasionally reduced, and the guns nevertheless well managed. The number of men appointed to the small arms, on board his Majesty's ships and sloops of war, by order of the admiralty, are,

Quarters ‖ Quarto.

Rate of the ſhip.	No. of men to the ſmall arms.
1ſt	150
2d	120
3d of 80 guns	100
— of 70 guns	80
4th of 60 guns	70
4th of 50 guns	60
5th	50
6th	40
Sloops of war	30

The lieutenants are uſually ſtationed to command the different batteries, and direct their efforts againſt the enemy. The maſter ſuperintends the movements of the ſhip, and whatever relates to the ſails. The boatſwain, and a ſufficient number of men, is ſtationed to repair the damaged rigging; and the gunner and carpenter, wherever neceſſary, according to their reſpective offices.

The marines are generally quartered on the poop and forecaſtle, or gang-way, under the direction of their officers; although, on ſome occaſions, they aſſiſt at the great guns, particularly in diſtant cannonading.

Quarters, at a ſiege, the encampment upon one of the moſt principal paſſages round a place beſieged, to prevent relief and convoys.

Head Quarters of an Army, the place where the commander in chief has his quarters. The quarters of generals of horſe are, if poſſible, in villages behind the right and left wings, and the generals of foot are often in the ſame place: but the commander in chief ſhould be near the centre of the army.

Quarters of Refreſhment, the place or places where troops that have been much haraſſed are put to recover themſelves during ſome part of the campaign.

Intrenched Quarters, a place fortified with a ditch and parapet to ſecure a body of troops.

Winter Quarters, ſometimes means the ſpace of time included between leaving the camp and taking the field; but more properly the places where the troops are quartered during the winter.

The firſt buſineſs, after the army is in winter-quarters, is to form the chain of troops to cover the quarters well: which is done either behind a river, under cover of a range of ſtrong poſts, or under the protection of fortified towns. Huſſars are very uſeful on this ſervice.

It ſhould be obſerved, as an invariable maxim, in winter-quarters, that your regiments be diſpoſed in brigades, to be always under the eye of a general officer; and, if poſſible, let the regiments be ſo diſtributed, as to be each under the command of its own chief.

QUARTERING, in heraldry, is dividing a coat into four or more quarters, or quarterings, by parting, couping, &c. that is, by perpendicular and horizontal lines, &c.

QUARTO-decimans. an ancient ſect in the Chriſtian church, who taught that Eaſter ſhould always be celebrated according to the cuſtom of the Jews, on the fourteenth day of the moon in the month of March, whenſoever that day fell out. And hence they derived their name *quarto decimani*, q. d. Fourteenthers. The Aſiatics were mightily attached to this opinion, pretending that it was built on the authority of St John, who was their apoſtle; and pope Victor could never bring them to obedience in this article, though he was upon the point of excommunicating them: but it is more probable he contented himſelf with menaces. See Easter.

Quartz.

QUARTZ, a genus of ſiliceous earths very common in Europe. According to Kirwan, the quartz are in general the pureſt of the ſiliceous kind, though moſt of them contain a ſlight mixture of other earths: the moſt obvious diſtinction among them ariſes from their opacity or tranſparency. Cronſtedt gives the following characteriſtics of it: 1. It is generally cracked throughout, even in the rock itſelf, whereby, as well as by its own nature, it breaks into irregular and ſharp fragments. 2. It cannot be eaſily made red hot, without cracking ſtill more. 3. It never decays in the air. 4. Melted with fixed alkali in a due proportion, it gives a more ſolid and fixed glaſs than any of the other ſiliceous ſtones. 5. When there has been no interruption in its natural accretion, it always cryſtallizes into hexagonal priſms pointed at both ends. 6. It is met with in clefts, fiſſures, and ſmall veins in rocks; it ſeldom forms large veins, and ſtill more rarely whole mountains, without a mixture of heterogeneous ſubſtances. It is found,

1. Pure, of ſeveral varieties, as, (1.) Solid, or having no viſible particles, and called *fat quartz*. This is either tranſparent, white, blue, or violet-coloured. The firſt kind is met with in the copper-mines in the northern part of Norway and Siberia, and has no regular form, but is as clear as the fineſt cryſtallized quartz, or rock cryſtal. (2.) *Grained quartz*, of a white or pale green colour, found in various places in Sweden. (3.) The *ſparry quartz*, which is the ſcarceſt of the whole, and ought not to be confounded with the white felt-ſpar, becauſe it is of a ſmoother appearance, and breaks into larger and more irregular planes. It is found of a whitiſh yellow, from the gold mines in Hungary; or white, from the iſland of Uto. Brunnich tells us, that the Hungarian gold and ſilver mines near Hodentch, which have veins frequently ſome fathoms wide, afford a kind of lamellated and porous quartz. It is met with of white, yellow, and blue colours, and it is ſometimes finely cryſtallized in pyramidical figures.

2. *Cryſtallized quartz*, or *rock cryſtal*. See Crystal.

3. *Impure quartz*. Of this there are two kinds, (1.) Mixed with iron, in form of a black calx. It is black, gloſſy, and contains a great quantity of iron. It is found in Sweden. (2.) Mixed with copper, and of a red colour, found in the ſame country.

Cronſtedt obſerves, that quartz in general, and eſpecially its cryſtals, are very commonly ſuppoſed, when yet in their ſoft and diſſolved ſtate, to have included within them ſome vegetables, for inſtance graſs and moſs. "This (ſays he) I cannot abſolutely deny; but it deſerves carefully to be examined if that which is ſhown as a graſs be not an aſbeſtos, or a ſtriated cockle; and the moſs only branched varieties filled with earth, which, by their being ramoſe, bear a vegetable appearance. It is very common in agates, and makes them of leſs value than they otherwiſe would be. This is moſt generally the caſe with thoſe ſtones which are ſhown as including vegetables; and, for my own part, I have

Quartz ‖ Quafi.

have never been fo fortunate as to meet with any others."

M. Magellan remarks, that quartz is one of the principal kinds of ftone which contain metals. Some of the Hungarian veins confift entirely of it, and the gold is fo minutely difperfed, that it cannot be difcerned by the beft microfcopes before it is feparated by pounding and wafhing. The width of the veins, fome of which are half a fathom, and fome ftill more, repay the trouble and expences, which the fmall quantity of gold would not otherwife counterbalance. Nature has not anywhere produced mountains of pure quartz; for though fome rocks in Sweden are ranked among the quartzes, they are undoubtedly mixed with heterogeneous matters. Near Lauterberg upon the Hartz are veins of this ftone from one to three fathoms wide, confifting of a loofe fand, in which they find the copper ore in nefts. In the Danifh ifle of Anhalt we meet with triangular quartz pebbles. There are likewife cryftals of quartz having water inclofed in them; fome fine pieces of this kind are to be met with in the Imperial cabinet at Vienna, &c.

Rock cryftals are generally found upon or among quartz, and are to be met with in all parts of the world. The greateft number are furnifhed to the European countries from Mount Saint Gothard in Switzerland.—Here large pieces, weighing from 5 to 800 pounds, were found at Grimfelberg; one of 1200 pounds was found fome years ago at Fifbach in the Wallais; and a piece fix feet long, four broad, and equally thick, was found in the ifland of Madagafcar, a place where thefe natural productions are of the moft extraordinary fize and perfection.

When great quantities of quartz are continually agitated by the fea or river water, they are fometimes reduced to fuch very minute parts as to be eafily carried away, fufpended in the water; and there are fands of fo minute a fize as to meafure lefs than the two or three hundredth part of an inch. Thefe are called *quickfands*. Immenfe tracts of land confift only of loofe fands, particularly along the fea-fhore in many parts of Europe. Some fuppofe that fea-water has the power of producing this fand out of its own fubftance; and their furfaces, in general, are fo polifhed, as to fhow that they could not be reduced in fize by rubbing againft each other; but we know not as yet that fuch a production has ever been demonftrated. When fand is about as big as peas, it is called gravel; and when it is free from faline and heterogeneous particles, it is employed in making mortar, and other economical purpofes. That which is very pure ferves for making flint-glafs, with red calces of lead, and the proper alkaline flux; but when mixed with ferruginous black fand, the glafs affumes a greenifh black colour. "This (fays M. Magellan) I have feen among the various fpecimens of glafs made by Mr E. Delaval, F. R. S. who produced a very fine tranfparent and colourlefs glafs out of the fame fand with which he had made fome of that black glafs, and this only by feparating from it all the ferruginous mixture."

QUASHING, in law, the overthrowing and annulling a thing.

QUASI-CONTRACT, in the civil law, an act without the ftrict form of a contract, but yet having the force thereof. In a contract there muft be the mutual confent of both parties, but in a *quafi-contract* one party may be bound or obligated to the other, without having given his confent to the act whereby he is obliged. For example: I have done your bufinefs, in your abfence, without your procuration, and it has fucceeded to your advantage. I have then an action againft you for the recovery of what I have difburfed, and you an action againft me to make me give an account of my adminiftration, which amounts to a *quafi-contract*.

Quafi ‖ Quaffia.

Quasi-Crime, or *Quafi-delict*, in the civil law, the action of a perfon who does damage, or evil, involuntarily. The reparation of *quafi-crimes* confifts in making good the damages, with intereft.

QUASS, a fermented liquor drunk in Ruffia. See PEASANT.

QUASSIA, in botany: A genus of the monogynia order, belonging to the decandria clafs of plants; and in the natural method ranking under the 14th order, *Gruinales*. The calyx is pentaphyllous; there are five petals; the nectarium is pentaphyllous; there are from two to five feed-cafes ftanding afunder, and monofpermous. There are three fpecies, the *amara*, *fimaruba*, and *excelfa* or *polygama*.

The quaffia amara grows to the height of feveral feet, and fends off many ftrong branches. The wood is of a white colour and light; the bark is thin and grey: the leaves are placed alternately on the branches, and confift of two pair of oppofite pinnæ, with an odd one at the end: all the leafets are of an elliptical fhape, entire, veined, fmooth, pointed, feffile, on the upper pagina of a deep green colour, on the under paler: the common footftalk is articulated, and winged, or edged, on each fide with a leafy membrane, which gradually expands towards the bafe of the pinnæ: the flowers are all hermaphrodite, of a bright red colour, and terminate the branches in long fpikes: the bracteæ or floral leaves are lance-fhaped or linear, coloured, and placed alternately upon the peduncles: the calyx is fmall, perfiftent, and five-toothed: the corolla confifts of five lance-fhaped equal petals, at the bafe of which is placed the nectary, or five roundifh, coloured, fcales: the filaments are ten, flender, fomewhat longer than the corolla, and crowned with fimple antheræ, placed tranfverfely: the receptacle is flefhy and orbicular: the germen is ovate, divided into five parts, and fupports a flender ftyle, longer than the filaments, and terminated by a tapering ftigma: the capfules are five, two-celled, and contain globular feeds. It is a native of South America, particularly of Surinam, and alfo of fome of the Weft Indian iflands. The root, bark, and wood, of this tree have all places in the materia medica. The wood is moft generally ufed, and is faid to be a tonic, ftomachic, antifeptic, and febrifuge.

Woodvill[e's] Medical [Bo]tany, vol. [...] p. 215.

The quaffia fimaruba is common in all the woodlands in Jamaica. It grows to a great height and confiderable thicknefs. The trunks of the old trees are black and a little furrowed. Thofe of the young trees are fmooth and gray, with here and there a broad yellow fpot. The infide bark of the trunk and branches is white, fibrous, and tough. It taftes flightly bitter. On cutting or ftripping off this bark, no milky juice iffues, as has been mentioned by various authors. The wood is hard, and ufeful for buildings. It fplits freely, and makes excellent ftaves for fugar hogfheads. It has no fenfible bitter tafte. The branches are alternate and fpreading. The leaves are numerous and alternate. On the upper fide, they are fmooth, fhining, and of a

Dr Wrigh[t's] Paper, Edi[n.] Tranf. vol. ii.

6 deep

deep green colour: on the under side they are white. The flowers appear about the beginning of April. They are of a yellow colour, and placed on spikes beautifully branched.

The fruit is of that kind called a *drupa*, and is ripe towards the end of May. It is of an oval shape, is black, smooth, and shining. The pulp is fleshy and soft; the taste a nauseous sweet. The nut is flattened, and on one side winged. The kernel is small, flat, and tastes sweet. The natural number of these drupæ is five on each common receptacle; but, for the most part, there are only two or three; the rest abort by various accidents. The roots are thick, and run superficially under the surface of the ground to a considerable distance. The bark is rough, scaly, and warted. The inside when fresh is a full yellow, but when dry paler. It has but little smell. The taste is bitter, but not very disagreeable. This is the true cortex simarubæ of the shops. This tree is known in Jamaica by the names of *mountain damson, bitter damson*, and *stave-wood*. The shops are supplied with this bark from Guiana; but now we may have it from our own islands at a moderate expence. On examining the fructification, Dr Wright found this tree to be a species of quassia. Under that name he sent it to Europe, and Linnæus adopted it into his system. There are male flowers on one tree and female flowers on another; and this is invariably the case in Jamaica.

Most authors who have written on the simaruba agree, that in fluxes it restores the lost tone of the intestines, allays their spasmodic motions, promotes the secretions by urine and perspiration, removes that lowness of spirits attending dysenteries, and disposes the patient to sleep; the gripes and tenesmus are taken off, and the stools are changed to their natural colour and consistence. In a moderate dose, it occasions no disturbance or uneasiness; but in a large doze it produces sickness at stomach and vomiting. Negroes are less affected by it than white people. Dr Cullen, however, says, "We can perceive nothing in this bark but that of a simple bitter; the virtues ascribed to it in dysentery have not been confirmed by my experience, or that of the practitioners in this country; and leaving what others are said to have experienced to be further examined and considered by practitioners, I can only at present say, that my account of the effect of bitters will perhaps explain the virtues ascribed to simaruba. In dysentery I have found an infusion of chamomile flowers a more useful remedy." The quassia excelsa or polygama was named by Sir Joseph Banks, Dr Solander, and Dr Wright, *pricrania amara*, (see PRICRANIA *Amara*.) It is ranked, however, by Mr John Lindsay, in a paper in the third volume of the Edinburgh Transactions, under *quassia*, who gives the following description of it. "It is very common in the woodlands of Jamaica, is beautiful, tall, and stately, some of them being 100 feet long, and ten feet in circumference eight feet above the ground. The trunk is straight, smooth, and tapering, sending off its branches towards the top. The outside bark is pretty smooth, of a light gray or ash colour, from various lichens. The bark of the roots is of a yellow cast, somewhat like the cortex simaruba. The inner bark is tough, and composed of fine flaxy fibres. The wood is of a yellow colour, tough, but not very hard. It takes a good polish, and is used as flooring. The leaves are sub-alternate; the small leaves are in pairs, from five to eight, standing opposite to each other on short footstalks, and ending with an odd one. They are of an oblong oval shape, and pointed; the ribs reddish, and the young leaves are covered with a fine brownish down. The flowers come out in bunches or clusters from the lower part of the last shoot before the leaves, and stand on round footstalks. The flowers are small, of a yellowish green colour, with a very small calyx. The male or barren tree has flowers nearly similar to the hermaphrodite, but in it there are only the rudiments of a style.

[...]eria [...]ca, [...]i. p. 75.

"The fruit is a smooth black drupa, round-shaped, and of the size of a pea. There is but little pulp, and the nut covers a round kernel. These drupæ are generally three, sometimes two, and often only one, attached sidewise to a roundish fleshy receptacle. It flowers in October and November, and its fruit is ripe in December and January. Except the pulp of the fruit, every other part of this tree has an intensely bitter taste. In taste and virtues it is nearly equal to the quassia of Surinam, and I am credibly informed is sold in London for the quassia amara; and it may be safely used in all cases where that drug has been thought proper, whether as an antiseptic, or in cases of weakness in the stomach and bowels. It may either be given alone, or joined with the Jesuit's bark. The happiest effects result from the use of this medicine in obstinate remitting fevers from marsh miasmata, in agues which had resisted the use of Jesuit's bark, and in dysenteries of long standing. It is in daily practice in dropsies from debility, either in simple infusions or tincture by itself, or joined with aromatics and chalybeates. Dr Drummond, an eminent physician in Jamaica, prescribes it with great success in the above cases, as well as in amenorrhæa, chlorosis, dyspepsia, and in that species of pica called *dirteating*, so fatal to a number of negroes.

"The bark of the quassia polygama, but especially the wood, is intensely bitter. They may both be used in various forms. In certain cases of dropsy, aromatics and preparations are joined to it, also in amenorrhæa and chlorosis; and in worm fevers, the cabbage-bark, or other vegetable anthelmintics."

QUATUORVIR, in antiquity, formerly written IIII. VIR, a Roman magistrate, who had three colleagues joined with him in the same administration, and had the care of conducting and settling the colonies sent into the provinces. There were also quatuorviri appointed to inspect and take care of repairs, &c.

QUAVER, in music, a measure of time equal to half a crotchet, or an eighth part of a semibreve.

QUAY. See KEY.

QUEBEC, a handsome and large town of America, and capital of Canada. The first place taken notice of upon landing here is a square of an irregular figure, with well-built houses on each side; on the back of which is a rock; on the left it is bounded by a small church; and on the right are two rows of houses, parallel to each other. There is another between the church and the harbour; as also another long row on the side of the bay. This may be looked upon as a kind of suburb; and between this and the great street is a very steep ascent, in which they have made steps for the foot-passengers to go up. This may be called the

the *Upper Town*, wherein is the biſhop's palace; and between two large ſquares is a fort where the governor lodges. The Recolets have handſome houſes over-againſt it, and on the right is the cathedral church: over-againſt this is the Jeſuits college, and between them are well-built houſes; from the fort runs two ſtreets, which are croſſed by a third, and between theſe is a church and a convent. In the ſecond ſquare are two deſcents to the river of St Charles. The Hotel Dieu is in the midway; and from thence are ſmall houſes, which reach to the houſe of the intendant. On the other ſide of the Jeſuits college, where the church ſtands, is a pretty long ſtreet in which is a nunnery. Almoſt all the houſes are built of ſtone, and there are about 7000 inhabitants; the fort is a handſome building, but not quite finiſhed. Quebec is not regularly fortified: but it cannot be eaſily taken; for the harbour is flanked with two baſtions, which at high tides are almoſt level with the water. A little above one of the baſtions is a demi-baſtion, partly taken out of the rock; and above it, on the ſide of the gallery of the fort, is a battery of 25 pieces of cannon: ſtill above this is a ſquare fort called the *citadel;* and the ways from one fortification to another are difficult to paſs. To the left of the harbour, on the ſide of the road, there are large batteries of cannon, and ſome mortars; beſides theſe, there are ſeveral other fortifications not very eaſy to be deſcribed. In 1711 the Britiſh fitted out a fleet with a deſign to conquer Canada, which failed on account of the raſhneſs of the admiral; who, contrary to the advice of his pilot, went too near the Seven iſles, and ſo loſt his largeſt ſhips, and 3000 of his beſt ſoldiers. It is about 300 miles north-weſt of Boſton in New-England. On October 18. 1759, it was taken by the Britiſh under the command of General Wolfe, who loſt his life in the battle, after he had the ſatisfaction to know that our troops were victorious. Admiral Saunders commanded a ſquadron of men of war, and did immenſe ſervice in reducing this place; there being not a man in the navy but what was active on this occaſion, not excepting the ſailors belonging to the tranſport veſſels. After this valuable acquiſition, all Canada came under the juriſdiction of the crown of Great Britain. W. Long. 69. 48. N. Lat. 46. 55.

QUEDA, a kingdom of Aſia, in the peninſula beyond the Ganges, and near the ſtrait of Malacca. The king is tributary to Siam. The principal town is of the ſame name, and ſaid to contain about 8000 inhabitants; and is ſubject to the Dutch. It has a harbour, and is 300 miles north of Malacca. E. Long. 100. 5. N. Lat. 7. 5.

QUEDLINGBURG, a town of Germany, in the circle of Upper Saxony, and on the confines of the duchy of Brunſwick. Here is a famous abbey, whoſe abbeſs is a princeſs of the empire, and who ſends deputies to the diets. Her contingent is one horſeman and ten footmen. The inhabitants of the town live by brewing, huſbandry, and feeding of cattle. It is 10 miles ſouth-eaſt of Halberſtadt, and 32 weſt of Bernberg. E. Long. 11. 34. N. Lat. 52. 1.

QUEEN, a woman who holds a crown ſingly.

The title of *queen* is alſo given by way of courteſy to her that is married to a king, who is called by way of diſtinction *queen-conſort;* the former being termed *queen-regent*. The widow of a king is alſo called *queen*, but with the addition of *dowager*. See *Royal-Family*.

Queen Charlotte's Sound, is ſituated at the northern extremity of the ſouthern iſland of New Zealand, near Cook's Strait, lying in 41. 6. of ſouth latitude, and 174. 19. of eaſt longitude. The climate of this ſound is much more mild than at Duſky Bay; and though there is not ſuch plenty of wild fowl and fiſh, the defect is ſufficiently compenſated by abundance of excellent vegetables. The hills about the ſound conſiſt moſtly of an argillaceous ſtone of a greeniſh grey, or bluiſh or yellowiſh brown colour. A green talkous or nephritic (by the jewellers called *jadde*) is likewiſe very common, together with horn-ſtone, ſhingle, ſeveral ſorts of flinty ſtones and pebbles, ſome looſe pieces of baſaltes, ſtrata of a compact mica or glimmer, with particles of quartz. Hence, Mr Forreſter thinks, there is reaſon to believe that this part of New Zealand contains iron-ore, and perhaps ſeveral other metallic ſubſtances. The country is not ſo ſteep as at Duſky Bay, and the hills near the ſea are generally inferior in height, but covered with foreſts equally intricate and impenetrable. Captain Cook ſowed the ſeeds of many vegetables in this place, that have uſeful and nutritive roots. He ſowed alſo corn of ſeveral ſorts, beans, kidney-beans, and peaſe. The dogs here are of the long-haired ſort, with pricked ears, and reſemble the common ſhepherd's cur, but they are very ſtupid animals. They are fed with fiſh, and even dogs fleſh, and perhaps human fleſh, which the natives alſo eat. Captains Cook and Furneaux left on theſe iſlands a boar and two ſows, with a pair of goats, male and female, with ſome geeſe, in order to benefit the natives and future generations of navigators. They left likewiſe among them a number of braſs medals guilt, on one ſide of which was the head of his preſent majeſty, with the inſcription George III. King of Great Britain, France, and Ireland, &c. On the reverſe, a repreſentation of two men of war, with the names Reſolution and Adventure over them; and the exergue, ſailed from England March MDCCLXXII.

Queen-Gold, is a royal duty or revenue belonging to every queen of England during her marriage to the king, payable by perſons in this kingdom and Ireland, on divers grants of the king by way of fine or oblation, &c. being one full tenth part above the entire fines, on pardons, contracts, or agreements, which becomes a real debt to the queen, by the name of *aurum reginæ*, upon the party's bare agreement with the king for his fine, and recording the ſame.

Queen's-County, a diviſion of the province of Leinſter in Ireland; ſo called from the popiſh Queen Mary, in whoſe reign it was firſt made a county by the earl of Suſſex, then lord-deputy. It is bounded on the ſouth by Kilkenny and Catherlogh; by King's county on the north and weſt; part of Kildare and Catherlogh on the eaſt; and part of Tipperary on the weſt. Its greateſt length from north to ſouth is 35 miles, and its breadth near as much; but it is unequal both ways. This county was anciently full of bogs and woods, though now pretty well incloſed, cultivated, and inhabited. The baronies contained in it are ſeven; and it ſends eight members to parliament.

Queen-Bee. See *Bee*, n° 3, &c.

QUEENBOROUGH, a town of the iſle of Shep-

pey in Kent, which sends two members to parliament, though consisting only of about 100 low brick houses, and scarce 350 inhabitants. The chief employment of the people here is oyster drudging; oysters being very plentiful, and of a fine flavour. E. Long. 0. 50. N. Lat. 51. 25.

QUEENS-FERRY, a town of Scotland, in the shire of Lothian, seated on the south side of the river Forth, 9 miles west of Edinburgh.

QUEI-LING-FOU, the capital of the province of Quangsi in China, has its name from a flower called *quei*, which grows on a tree resembling a laurel; it exhales so sweet and agreeable an odour, that the whole country around is perfumed with it. It is situated on the banks of a river, which throws itself into the Taho; but it flows with such rapidity, and amidst so narrow valleys, that it is neither navigable nor of any utility to commerce. This city is large, and the whole of it is built almost after the model of our ancient fortresses; but it is much inferior to the greater part of the capitals of the other provinces. A great number of birds are found in the territories belonging to it, the colours of which are so bright and variegated, that the artists of this country, in order to add to the lustre of their silks, interweave with them some of their feathers, which have a splendor and beauty that cannot be imitated. Quei-ling has under its jurisdiction two cities of the second class and seven of the third.

QUEI, in natural history, is a name given by the Chinese to a peculiar earth found in many parts of the east. It is of the nature of an indurated clay, and in some degree approaches to the talks, as our steatites and the galactites do. It is very white and abstersive, used by the women of China to take off spots from the skin, and render it soft and smooth, as the Italian ladies use talk of Venice. They sometimes use the fine powder of this stone dry, rubbing it on the hands and face after washing; sometimes they mix it in pomatum.

QUERCI, a province of Guienne in France; bounded on the north by Limosin, on the east by Rouergue and Auvergne, on the south by Upper Languedoc, and on the west by Agenois and Perigord. It is divided into Upper and Lower; and is fertile in corn, wine, and fruits. Cahors is the capital town.

QUERCUS, the OAK-TREE: A genus of the polyandria order, belonging to the monoecia class of plants; and in the natural method ranking under the 50th order, *Amentaceæ*. The calyx is nearly quinquefid; there is no corolla; the stamina are from five to ten in number. The female calyx is monophyllous, very entire, and scabrous. There is no corolla; the styles are from two to five; and there is an ovate seed. See OAK.

Species. 1. The robur, or common English oak, grows from about 60 or 70 to 100 feet high, with a prodigious large trunk, and monstrous spreading head; oblong leaves, broadest towards the top, the edges acutely sinuated, having the angles obtuse. There is a variety, having the leaves finely striped with white. This species grows in great abundance all over England, in woods, forests, and hedge-rows; is naturally of an amazing large growth; there being accounts of some above 100 feet stature, with wonderful large trunks and spreading heads; and is supposed to continue its growth many centuries.

2. The prinus, or chesnut-leaved American oak, grows 50 or 60 feet high; having large oblong-oval smooth leaves pointed both ways, the edges sinuated-serrated, with the sinuses uniformly round.

3. The phellos, or willow-leaved American oak, grows 40 or 50 feet high, having long narrow smooth entire leaves, like those of the willow. There is a variety called the *dwarf willow-leaved oak*.

4. The alba, or white Virginian oak, grows 30 or 40 feet high, having a whitish bark, with long obliquely-pinnatifid light-green leaves, the sinuses and angles obtuse.

5. The nigra, or black Virginian oak, grows 30 or 40 feet high, having a dark-coloured bark, large wedge-shaped slightly-trilobated leaves.

6. The rubra, or red Virginian oak, grows about 60 feet high, having a dark-greyish bark, long obtusely-sinuated leaves, with the sinuses terminated by bristly points, and have sometimes red spotted veins, but generally dyeing in autumn to a reddish colour, remaining on the trees late in the season.

7. The esculus of Pliny, or cut-leaved Italian oak, grows about 30 feet high, having a purplish bark, oblong deeply-sinuated smooth leaves, and long slender close-sitting acorns in very large cups.

8. Ægilops, or large prickly-cupped Spanish oak, grows 70 or 80 feet high or more, with a very large trunk, and widely-spreading head, having a whitish bark, large oblong-oval deeply-serrated smooth leaves, the serratures bowed backward, and large acorns placed in singularly large prickly cups. This is a noble species, almost equal in growth to our common English oak.

9. Cerris, or smaller prickly-cupped Spanish oak, grows 30 or 40 feet high, and has oblong lyre-shaped pinnatifid transversely-jagged leaves, downy underneath, and small acorns placed in prickly cups.

10. The ilex, or common evergeen oak, grows 40 or 50 feet high, having a smooth bark, oval and oblong undivided serrated petiolated leaves, downy and whitish underneath. The varieties are, broad-leaved, narrow-leaved, and sometimes both sorts and other different shaped leaves on the same tree, also sometimes with sawed and prickly leaves.

11. The gramuntia, or Montpelier holly-leaved evergreen oak, grows 40 or 50 feet high; and has oblong-oval, close-sitting sinuated spinous leaves, downy underneath, bearing a resemblance to the leaves of holly.

12. The suber, or cork-tree, grows 30 or 40 feet high, having a thick, rough, fungous, cleft bark, and oblong-oval undivided serrated leaves, downy underneath. This species furnishes that useful material cork; it being the bark of the tree, which becoming of a thick fungous nature, under which, at the same time, is formed a new bark, and the old being detached for use, the tree still lives, and the succeeding young bark becomes also of the same thick spongy nature in six or seven years, fit for barking, having likewise another fresh bark forming under it, becoming cork like the others in the like period of time; and in this manner these trees wonderfully furnish the cork for our use, and of which is made the corks for bottles, bungs for barrels, and numerous other useful articles. The tree grows in great plenty in Spain and Portugal, and from these countries we receive the cork. The Spaniards

Quercus.

burn it, to make that kind of light black we call Spanish black, used by painters. Cups made of cork are said to be good for hectical persons to drink out of. The Egyptians made coffins of cork; which being lined with a resinous composition, preserved dead bodies uncorrupted. The Spaniards line stone-walls with it, which not only renders them very warm, but corrects the moisture of the air.

13. The coccifera, scarlet, or kermes oak, grows but 14 or 15 feet high, branching all the way, and of bushy growth; with large oval, undivided, indented, spinous leaves; and producing small glandular excrescences, called *kermes* or *scarlet grain*, used by the dyers. The small scarlet glands found in this tree, is the effect of certain insects depositing their eggs betwixt the bark of the branches and leaves, causing an extravasation of the sap, and forming the excrescence or substance in question, which being dried is the kermes or scarlet pastel.

14. The Molucca, Moluccan oak, commonly called *American live oak*, grows about 40 feet high, having oval, spear-shaped, smooth, entire leaves, and small oblong eatable acorns.

All the above 14 species of quercus produce flowers annually in the spring, about April or May, of a yellowish colour, but make no ornamental appearance, and are males and females separated in the same tree; the males being in loose amentums, and the females sitting close to the buds in thick leathery hemispherical calyxes, succeeded by the fruit or acorns, which are oval nuts fixed by their base into rough permanent cups, and mostly sit quite close, and some on short footstalks, ripening in autumn; which in the common English oak is in great abundance, and often in tolerable plenty on some of the other sorts: those of all the kinds serve for propagating their respective species; they are also excellent food for swine and deer, the common oak in particular.

Uses, &c. Oak-trees, of all the above sorts, may be employed in gardening to diversify large ornamental plantations in out-grounds, and in forming clumps in spacious lawns, parks, and other extensive opens; the evergreen kinds in particular have great merit for all ornamental purposes in gardens. But all the larger growing kinds, both deciduous and evergreens, demand esteem principally as first-rate forest-trees for their timber. The English oak, however, claims precedence as a timber-tree, for its prodigious height and bulk, and superior worth of its wood. Every possessor of considerable estates ought therefore to be particularly assiduous in raising woods of them, which is effected by sowing the acorns either in a nursery and the plants transplanted where they are to remain, or sowed at once in the places where they are always to stand. All the sorts will prosper in any middling soil and open situation, though in a loamy soil they are generally more prosperous: however, there are but few soils in which oaks will not grow; they will even thrive tolerably in gravelly, sandy, and clayey land, as may be observed in many parts of this country of the common oak.

The oak is of the utmost importance to Britain, and its cultivation deserves the utmost attention. Much, therefore, to the honour of the members of the *London Society for encouraging Arts, Manufactures, and Commerce*, they have excited particular attention to it; and many excellent observations, drawn from practice, will be found in their Transactions.

The propagation of the striped-leaved varieties of the common oak, and any particular variety of the other species, must be effected by grafting, as they will not continue the same from seed: the grafting may be performed upon any kind of oakling-stocks raised from the acorns, and train them for standards like the others.

The oak is remarkable for its slowness of growth, bulk, and longevity.* It has been remarked that the trunk has attained to the size only of 14 inches in diameter, and of some to 20, in the space of fourscore years. As to bulk, we have an account of an oak belonging to Lord Powis, growing in Broomfield wood, near Ludlow in Shropshire, in the year 1764, the trunk of which measured 68 feet in girth, 23 in length, and which, reckoning 90 feet for the larger branches, contained in the whole 1455 feet of timber, round measure, or 29 loads and five feet, at 50 feet to a load.

The Greendale oak, &c. we have already mentioned (see Oak). In the opinion of many, the Cowtharp oak near Wetherby in Yorkshire is the father of the forest. Dr Hunter, in his edition of Evelyn, has given an engraving of it. Within three feet of the surface he says it measures 16 yards, and close to the ground 26. In 1776, though in a ruinous condition, it was 85 feet high, and its principal limb extended 16 yards from the bole. The foliage was very thin. If this measurement were taken as the dimension of the *real stem*, the size of this tree would be enormous; but, like most very large trees, its stem is short, spreading wide at the base, the roots rising above the ground like buttresses to the trunk, which is similar not to a cylinder but to the frustum of a cone. Mr Marsham says, "I found it in 1768, at four feet, 40 feet 6 inches; at five feet, 36 feet 6 inches; and at six feet, 32 feet 1 inch." In the principal dimensions then, *the size of the stem*, it is exceeded by the Bentley oak; of which the same writer gives the following account: "In 1759 the oak in Holt-Forest, near Bentley, was at 7 feet 34 feet. There is a large excrescence at 5 and 6 feet that would render the measure unfair. In 1778, this tree was increased half an inch in 19 years. It does not appear to be hollow, but by the trifling increase I conclude it not sound." These dimensions, however, are exceeded by those of the Boddington oak. It grows in a piece of rich grass land, called the *Old Orchard Ground*, belonging to Boddington Manor-Farm, lying near the turnpike-road between Cheltenham and Tewksbury, in the Vale of Gloucester. The stem is remarkably collected at the root, the sides of its trunk being much more upright than those of large trees in general; and yet its circumference at the ground is about 20 paces: measuring with a two-foot rule, it is more than 18 yards. At three feet high it is 42 feet, and where smallest, *i. e.* from five to six feet high, it is 36 feet. At six feet it swells out larger, and forms an enormous head, which has been furnished with huge, and probably extensive, arms. But time and the fury of the wind have robbed it of much of its grandeur; and the greatest extent of arm in 1783 was eight yards from the stem.

In the Gentleman's Magazine for May 1794 we have an account of an oak tree growing in Penshurst park

park in Kent, together with an engraving. It is called the *Bear* or *Bare oak*, from being supposed to resemble that which Camden thought gave name to the county of Berkshire. The tradition at Penshurst is that it is the very tree planted on the day that the celebrated Sir Philip Sydney was born. "Some late writers (says Mr Rawlet) have questioned this, and think that to have been a different tree, which was cut down some years ago, and was indeed much larger than this. I remember being once in the hollow of the present oak with the late Sir John Cullum; and his opinion then was, that its antiquity was greater than the period assigned. But, I assure you, the tradition of this place is constant for this tree; and, in confirmation of it, an old lady of 94 years of age, now living, has told me, that all the tenants used to furnish themselves with boughs from this tree, to stick in their hats, whenever they went to meet the earls of Leicester, as was always the custom to do at the end of the park when they came to reside at their seat here. This fine old oak stands upon a plain about 500 yards from their venerable mansion, near a large piece of water called *Lancup-well*. Ben Jonson and Waller have particularly noticed it; and, from the distinguished owners of this place, it may be truly said to stand on classic ground. Within the hollow of it there is a seat, and it is capable of containing five or six persons with ease. The bark round the entrance was so much grown up, that it has lately been cut away to facilitate the access. The dimensions of the tree are these:

	Feet.	Inches.
Girth close to the ground - -	35	6
Ditto one foot from ditto -	27	6
Ditto five feet from ditto - -	24	0
Height taken by shadow -	73	0
Girth of lowest, but not largest, limb	6	9

With respect to longevity, Linnæus gives account of an oak 260 years old: but we have had traditions of some in England (how far to be depended upon we know not) that have attained to more than double that age. Mr Marsham, in a letter to Thomas Beevor, Esq; Bath Papers, Vol. I. p. 79, makes some very ingenious calculations on the age of trees, and concludes from the increase of the Bentley oak, &c. that the Fortworth chesnut is 1100 years old.

Besides the grand purposes to which the timber is applied in navigation and architecture, and the bark in tanning of leather, there are other uses of less consequence, to which the different parts of this tree have been referred. The Highlanders use the bark to dye their yarn of a brown colour, or, mixed with copperas, of a black colour. They call the oak *the king of all the trees in the forest*; and the herdsman would think himself and his flock unfortunate if he had not a staff of it. The acorns are a good food to fatten swine and turkeys; and, after the severe winter of the year 1709, the poor people in France were miserably constrained to eat them themselves. There are, however, acorns produced from another species of oak, which are eaten to this day in Spain and Greece, with as much pleasure as chesnuts, without the dreadful compulsion of hunger.

Quercus Marina, the *Sea Oak*, in botany, the name of one of the broad-leaved dichotomous sea-fucuses. It is not agreed, among the late botanists, what was the sea oak of Theophrastus; and the most ancient botanists, Clusius and Cæsalpinus, suppose it to have been a species of the shrubby coralline; but that seems by no means to have been the case, since Theophrastus says his sea oak had a long, thick, and fleshy leaf; whence we may much more naturally conclude it to have been of the fucus class.

QUERIA, in botany: A genus of the trigynia order, belonging to the triandria class of plants; and in the natural method ranking under the 22d order, *Caryophillei*. The calyx is pentaphyllous; there is no corolla; the capsule is unilocular, and trivalved, with one seed. There are two species, *viz*. hispanica and canadensis.

QUESNE (Abraham du), marquis of Quesne, admiral of the naval forces of France, and one of the greatest men of the last age, was born in Normandy in 1610. He contributed to the defeating of the naval power of Spain before Gattari; was dangerously wounded before Barcelona in 1642, and on other occasions: he went into the service of the Swedes, and became vice-admiral; gave the Danes an entire defeat, killed their admiral, and took his ship. He was recalled into France in 1647, and commanded the squadron sent to Naples. The sea-affairs of France being much fallen, he fitted out divers ships for the relief of the royal army that blocked up Bourdeaux; which was the principal cause of the surrender of the town. He was very fortunate in the last wars of Sicily, where he beat the Dutch thrice, and De Ruyter was killed. He also obliged the Algerines to sue for peace from France in a very humble manner. In short, Asia, Africa, and Europe, felt the effects of his valour. He was a Protestant; yet the king bestowed on him the land of Bouchet, and to immortalize his memory gave it the name of that great man. He died in 1688.

QUESTION, in logic, a proposition stated by way of interrogation.

Question, or *Torture*. See Rack.

QUESTOR, or Quæstor, in Roman antiquity, an officer who had the management of the public treasure.

The questorship was the first office any person could bear in the commonwealth, and gave a right to sit in the senate.

At first there were only two; but afterwards two others were created, to take care of the payment of the armies abroad, of selling the plunder, booty, &c. for which purpose they generally accompanied the consuls in their expeditions; on which account they were called *peregrini*, as the first and principal two were called *urbani*.

The number of questors was afterwards greatly increased. They had the keeping of the decrees of the senate: and hence came the two officers of *questor principis*, or *augusti*, sometimes called *candidatus principis*, whose office resembled in most respects that of our secretaries of state; and the *questor palatii*, answering in a great measure to our lord-chancellor.

QUEUE, in heraldry, signifies the tail of a beast: thus, if a lion be borne with a forked tail, he is blazoned double-queued.

QUEVEDO de Villegas (Francisco), a celebrated Spanish poet, born at Madrid in 1570. He was descended from a noble family, and was made a knight of

of St James; but was thrown into prison by order of Count Olivarez, whose administration he satirized in his verses, and was not set at liberty till after that minister's disgrace. Quevedo wrote some heroic, lyric, and facetious poems. He also composed several treatises on religious subjects, and has translated some authors into Spanish. He died in 1645. The most known of his works are, 1. The Spanish Parnassus. 2. The Adventurer Buscon. 3. Visions of Hell Reformed, &c. Quevedo was one of the greatest scholars and most eminent poets of his time. His youth was spent in the service of his country in Italy, where he distinguished himself with the utmost sagacity and prudence. His moral discourses prove his sound doctrine and religious sentiments, while his literary pieces display his infinite judgment and refined taste. His great knowledge of Hebrew is apparent from the report of the historian Mariana to the king, requesting that Quevedo might revise the new edition of the Bible of Arias Montanus. His translations of Epictetus and Phocylides, with his imitations of Anacreon, and other Greek authors, show how well he was versed in that language: that he was a Latin scholar, his constant correspondence, from the age of twenty, with Lipsius, Chifflet, and Scioppius, will sufficiently illustrate. As a poet, he excelled both in the serious and burlesque style, and was singularly happy in that particular turn we have since admired in Butler and Swift. His library, which consisted of about five thousand volumes, was reduced at his death to about two thousand, and is preserved in the convent of St Martin at Madrid.

QUICK, or *Quickset Hedge*, among gardeners, denote all live hedges, of whatever sort of plants they are composed, to distinguish them from dead hedges; but in a more strict sense of the word, it is restrained to those planted with the hawthorn, under which name those young plants or sets are sold by the nursery-gardeners who raise them for sale. See the article Hedges.

QUICKLIME, a general name for all calcareous substances when deprived of their fixed air; such as chalk, limestone, oyster-shells, &c. calcined. See Chemistry, nº 511, 748, 837, and 914.

Quicklime has the following properties. 1. It is entirely soluble in water, with which it unites so rapidly as to occasion considerable heat. When exposed to air, it imbibes moisture from thence. When united with as much water as is sufficient to make it a fluid paste, it is called *slaked lime*. Water saturated with quicklime is called *lime-water*. According to Brandt, lime-water contains about one part of quicklime to 700 or 800 parts of water. Slaked lime, or lime-water, being exposed to the atmosphere, attract from thence particles of fixable air which float in it, by which means the quicklime is rendered mild, insoluble in water, and therefore appears on the surface of the lime-water, or of the slaked lime where this combination happens, in the state of mild or combined calcareous earth, convertible by a second calcination into quicklime, and is called *cream of lime*.

If the earth dissolved in lime-water be precipitated from thence by any substance containing fixable air, as by mild alkalis or magnesia, it will unite with this air, become mild, and resume its former weight and properties which it possessed before calcination. But if it be precipitated from the water by means of some substance which does not contain fixable air, but which is more strongly disposed than the earth to unite with the water, for instance, spirit of wine, the earth thus precipitated will be in the state of quicklime, that is, caustic, and soluble in water.

2. Quicklime unites with acids without effervescence, which is nothing else than an extrication of the fixable air, of which quicklime has been already deprived. It nevertheless saturates as much acid as it would have done if it had not been calcined.

3. Quicklime is more powerfully disposed to unite with fixable air than fixed or volatile alkalis, or magnesia. Hence, when treated with these substances, it takes from them their fixable air, and is itself rendered mild, and restored to its original weight and properties. Thus two drams of chalk, having been by calcination reduced to one dram and eight grains of quicklime, were thrown into a filtrated solution of an ounce of mild fixed alkali in two ounces of water, and digested during some time; by which the calcareous earth became mild, and weighed one dram and 58 gr. By means of magnesia, the calcareous earth may be precipitated from lime-water; and this earth is found to be mild, and to have deprived the magnesia of its fixable air. By depriving alkalis of their fixable air, quicklime renders them more caustic and solvent, for the same reason that itself is by this privation of air rendered more caustic and powerfully solvent. This increase of causticity and dissolving power is consistent with a general rule, namely, that the more simple or less compounded any body is, that is, the less its general tendency to union is satisfied, the more disposed it is to unite with or dissolve other substances.

4. Quicklime has a disposition to unite with sulphur, with which it forms a hepar of sulphur, similar to that made by sulphur united with an alkali, and, like this, soluble in water. It is also disposed to unite with oils and with animal and vegetable matters, with respect to which it discovers a caustic and corrosive property.

5. Quicklime mixed with sand forms a mass which hardens, and is used as a cement or mortar.

All these properties of quicklime have been the objects of consideration to the chemists and philosophers; who have, as usual, been divided in their opinions on the subject. The evident resemblance of the action of quicklime to fire, has given occasion for one party to derive all the active properties of this substance from fire; while, on the other hand, its want of heat, and incapacity of setting bodies on fire, unless by an accession of water, were objections altogether insurmountable. On the other hand, those who denied the materiality of fire, and affirmed that it consists only in a motion mechanically produced among the particles of bodies, were altogether at a loss to show a reason why this motion, or any thing resembling it, should continue perhaps for months after the exciting cause is taken away. To remove this difficulty, some have had recourse to the action of a latent acid communicated to the quicklime by the fire; and which one chemist (Mr Meyer) has distinguished by the name of *acidum pingue*. But on this hypothesis it may be remarked in the first place, that the action of acids is as difficult to be explained as that of fire; and, in the second place, that as all substances, by calcination into quicklime, lose considerably of their weight,

weight, it seems very improbable that they should acquire an acid or any other substance which could increase their weight. Besides, from the experiments of Dr Black, it appears that the diminution of weight in calcareous substances is owing to their parting with a quantity of fixed air, the weight of which is much more considerable than that of any moisture or fatty matter they contain. The loss of this fixed air is now also universally allowed to be the reason of the causticity of the quicklime, as its superior attraction for fixed air is looked upon to be the reason why it renders fixed and volatile alkalis caustic like itself. The only question therefore can be, By what means are the calcareous earths deprived of their fixed air? To this question the answer is evident, namely, that the action of the fire expels the fixed air; and if this is the case, it is evident, that to this action of fire, continued, the caustic properties of the lime are owing.

We come now to the discussion of the question, Whether quicklime is to be considered as a pure earth, or a combination of it with something else?—Most of the chemists, since the discovery of fixed air, have been inclined to think that quicklime is a pure earth uncombined with any thing else, and that it approaches more nearly to the state of elementary earth than any other. But this opinion seems not to have a solid foundation; for there are other earths, such as the basis of alum, which, as far as they can be examined by us, are equally pure with quicklime, and yet discover not the smallest causticity, even after the most violent calcination. Besides, from the property which quicklime has of depriving alkaline salts of their fixed air, we may learn, that there exists in it, when kept by itself, a certain principle which prevents it from absorbing again the fixed air, with which it was once so closely united, except in certain circumstances. It is well known, that fixed alkalis, as well as those which are volatile, will absorb fixed air from the common atmosphere; and hence, tho' they are prepared in the most caustic state, they will in a very short time become mild by an exposure to the atmosphere; nay, it requires no small degree of care to prevent the atmosphere from having as much access to them as is necessary to change them from a caustic to a mild state. Now, as these substances thus attract the fixed air from the atmosphere, it thence appears that the atmosphere parts very readily with the fixed air which it contains. The quicklime, however, though it has a greater attraction for fixed air than the alkalis, yet does not become near so soon mild from exposure to the air as the alkalis which have less attraction than itself. Hence the necessary inference must be, that quicklime, after being once calcined, instead of attracting, repels fixed air, unless it is placed in certain circumstances, wherein the repelling power is destroyed, and the attractive power again manifests itself. Now it is manifest, that the power which originally repelled the fixed air was the action of fire; and consequently, while the quicklime refuses to attract fixed air, we must conclude that it is the same action which prevents the union. Quicklime therefore is not a pure earth, but a combination of a pure earth with fire; just as chalk, or limestone uncalcined, is not a pure earth, but a combination of a pure earth with fixed air. In all chemical trials, then, where quicklime is used, the double elective attraction will manifest itself as much as in a combination of different salts, metals, and acids. Thus when water is poured on quicklime, the attraction between that element and earth is stronger than the attraction between earth and fire. The consequence is, that the water expels the fire, just as vitriolic acid poured upon sea-salt expels the marine acid. The fire, then, having nothing with which it can form a chemical combination, becomes sensible to the touch, first making the lime very hot, and then gradually dissipating in the atmosphere. However, as the water combines with the earth but in very small quantity, it can only expel the fire from that quantity with which it does combine; and consequently the lime still retains its caustic quality, though in a degree somewhat milder than what it was originally. We must also consider, that water itself has a considerable attraction for fire as well as for earth; and the consequence of this must be, that part of the lime will be dissolved in the water, if more of that element is added than what the earth can absorb without losing the form of a dry powder. Hence the origin of lime-water, which is only a small quantity of lime in its caustic state dissolved in a large quantity of water. This dissolution is owing to the double attraction of fire to earth and water; for as long as the water can admit the calcined earth to that intimate union with itself which is called a *chemical combination*, the earth must still retain all the causticity which the fire gives it, and dissolve in the water. When the earth is in too large quantity to be thus combined with the water, the latter is only absorbed into the pores of the earth, where by its bulk it splits the stone or calcined matter all to pieces, and reduces it to an impalpable powder, expelling a proportionable quantity of fire from those pores which it now occupies. The water, however, is capable of radically dissolving but a very small portion of calcined earth: and therefore the same quantity of quicklime will serve for preparing lime-water a great number of times over; but at last a large quantity is left, which seems to be quite inert, and has lost the properties of quicklime. Those who have tried the experiment of lixiviating lime with fresh quantities of water till it ceases to be soluble, have fixed the proportion of soluble matter in the lime at about one-third of the whole; but from Dr Black's experiments it appears that quicklime may all be dissolved in water at once, provided the water is in sufficient quantity. Its inactivity, therefore, after repeated affusions of water, must be owing to some change produced by the water; but whether this is owing to an absorption of all the fire it contained by the great quantity of water, or to a supply of fixed air given by the water, has not yet been determined by any experiment.

If, instead of pouring cold water upon quicklime, we pour that which is already heated, the absorption is much less complete; because the water, having already a superfluous quantity of heat, is resisted by that which is contained in the quicklime in a latent state; and hence it is a general observation, that hot water is less proper for slaking lime than cold. But if we pour on any acid upon quicklime which contains a great quantity of fire in a latent state, and has likewise a violent attraction for the earth, a much greater degree of heat is produced than with simple water. With the vitriolic acid, indeed, this is not so well perceived, if the common

Quicklime. mon calcareous earths are made use of; because their insolubility in this acid diminishes its effect: but if, instead of these earths, we take magnesia newly calcined, the heat is so great, that the aqueous vapour, not having time to evaporate slowly, is driven off with a considerable explosion. If the common calcareous earths, well calcined, are dissolved in the nitrous acid, a most violent degree of heat is produced; more indeed than in any other case where a liquid is concerned; for the nitrous acid itself contains a great deal of latent heat; the quicklime does the same; and by the intimate union of the earth with the acid, all this latent heat, at least a great part of it, both in the quicklime and spirit of nitre, is displaced, and attacks the aqueous fluid, as being nearest to it; from whence it is dissipated in the air, or absorbed by the neighbouring substances. The same thing happens, only in a less degree, when the marine acid is employed.

When quicklime is mixed with a solution of mild alkali, a double decomposition, and two new compositions, take place. The quicklime may be considered as a combination of earth and fire, while the alkali in the present case acts as a combination of salt and air. These two substances, therefore, are no sooner put into such circumstances as enable them to act on each other, than the quicklime attracts the air from the alkali, and gives its own fire in exchange, which the alkali takes up, and thus is rendered caustic, while the quicklime becomes mild. Nevertheless, though the alkali here seems to have the greater attraction for fire, and the quicklime for air; yet it appears that the alkali is by no means capable of keeping the fire which it has imbibed for any length of time: for no sooner is it exposed to the action of the air, than it parts with the fire which it had imbibed, regains its air, and becomes mild. This, however, in all probability is owing to its extreme solubility in water while in a caustic state; for quicklime itself, when dissolved in water, very easily regains its fixed air, nay, even more than it contains in a natural state. See the article Salt.

On the whole, then, the properties of quicklime may be explained in a very easy manner on Dr Black's principle of latent heat. That heat consists in a latent state in quicklime, as well as in vapour, we have incontestable proofs; because, in all cases where quicklime changes its nature and becomes more mild, a degree of heat is produced, and which is always proportionable to the change made on the quicklime. In the making of quicklime, therefore, the air is expelled, and a proportional quantity of fire enters; in dissolving it in an acid, slaking, &c. an acid, air, or water, expels part of the heat, which then becomes sensible. By long exposure to the air, the heat gradually evaporates; the fixed air resumes its place; and the quicklime being thus increased in bulk, embraces those bodies very closely which lie nearest to it; insomuch that, when mixed with sand and stones, it will harden with them almost into the solidity of a rock (see Cement and Mortar). When mixed with animal or vegetable substances, it destroys or decompounds them, both by the action of its internal heat, and by its attraction for a certain acid contained in the animal substances, and an oily matter in the vegetables; and hence its property of burning cloth, though its attraction for the oily matter just mentioned makes it an excellent whitener when properly applied. See Bleaching.

Quicksilver. QUICKSILVER, or mercury, one of the perfect metals, and so fusible that it cannot be reduced to a solid state but by the most intense degree of cold, scarcely, if at all, under 40° below o of Fahrenheit's thermometer. See Congelation. For the method of extracting quicksilver from its ore, &c. see Metallurgy, p. 454, and 475. For the various preparations, &c. from it, see Chemistry *Index* at *mercury* and *quicksilver*, and Pharmacy *Index* at *mercury* and *quicksilver*. And for its use in medicine, see Medicine, n° 350, and Mercury.

It is found, 1. Native, as in the mines of India, Friuli, Lower Austria, Deux Ponts, &c. flowing through beds of stone, and collecting in the clifts or cavities of rocks. In these mines, however, Mr Kirwan is of opinion that it is mixed with some other metal, as the globules into which it is divided are not perfectly spherical. In Sweden and Germany it has been found united to silver in form of a hard and somewhat brittle amalgam. It has also been observed visibly diffused through masses of clay or stone, of a white, red, or blue colour, and very heavy in Spain and Idria; and in Sicily in beds of chalk.

Mines of quicksilver, however, are very rare, insomuch that, according to the calculations of Hoffman, there is 50 times more gold got every year out of the mines than mercury and its ores. But Dr Lewis, in his notes upon Newmann, says, that Cramer suspects that Hoffman only meant five times instead of 50; but neither the Latin nor the English edition of this author expresses any such thought; on the contrary, he adopts the same opinion; and only adds, that mercury is much more frequently met with than is commonly believed; but being so volatile in the fire, it often flies off in the roasting of ores, and escapes the attention of metallurgists.

According to Newmann, the mines of Idria have produced at the rate of 231,778 pounds weight of mercury *per annum*; but those of Almaden in Spain produce much more. The chemists of Dijon inform us, that their annual produce is five or six thousand quintals, or between five and six hundred thousand pounds weight. In the year 1717 there were upwards of 2,500,000 pounds of quicksilver sent from them to Mexico, for the amalgamation of the gold and silver ores of that country.

At Guacanvelica in Brasil the annual produce of the mines, according to Bomare, amounts to one million of pounds, which are carried overland to Lima, thence to Arica, and lastly to Potosi for the same purpose.

Besides these mines there are others in Brasil near Villa Rica, where such a quantity of cinnabar and native running mercury are found near the surface of the earth, that the black slaves often collect it in good quantities, and sell it for a trifling price to the apothecaries; but none of these mines have ever been worked or taken notice of by the owners. Gold naturally amalgamated with mercury is likewise met with in the neighbourhood of that place; and it is said that almost all the gold mines of that country are worked out by simply washing them out with running water, after reducing into powder the hard ores, which are sometimes imbedded in quartzose and rocky matrices.

In the duchy of Deux Ponts and in the Lower Austria

Quick-silver.

ftria the quickfilver flows from a fchiftofe or ftony matrice, and is probably, fays Mr Kirwan, mixed with fome other metal, as its globules are not perfectly fpherical. The mines of Friuli are all in fimilar beds or ftrata. The metal is likewife found vifibly diffufed through maffes of clay or very heavy ftone, of a white, red, or blue colour; of which laft kind are the mines of Spain, fome of Idria, and of Sicily. Mafcagni found fluid quickfilver, as well as native cinnabar and mineral ethiops, near the lake of Travale in the duchy of Sienna; but the quantity was fo fmall as not to be worth the expence of working. On the other hand, the following mines afford profits to the owners after clearing all expences, viz. thofe at Kremnitz in Hungary; at Horowitz in Bohemia; Zorge in Saxony; Wolfsteim, Stahlberg, and Moefchfeld in the Palatinate. Mercury is alfo brought from Japan in the Eaft Indies; but the greateft part of what is fold in Europe as Japan cinnabar is faid to be manufactured in Holland.

Lemery, Pomet, and others, lay down fome external marks by which we may diftinguifh thofe places where there are mines of quickfilver, viz. thick vapours like clouds arifing in the months of April and May; the plants being much larger and greener than in other places: the trees feldom bearing flowers or fruit, and putting forth their leaves more flowly than in other places; but, according to Neumann, thefe marks are far from being certain. They are not met with in all places where there is quickfilver, and are obferved in places where there is none. Abundance of thefe cloudy exhalations are met with in the Hartz foreft in Germany, though no mercury has ever been found there; to which we may add, that though vaft quantities of mercurial ores are found at Almaden in Spain, none of the above-mentioned indications are there to be met with.

Native mercury was formerly fought from the mines of Idria with great avidity by the alchemifts for the purpofe of making gold; and others have fhowed as ridiculous an attachment to the Hungarian cinnabar, fuppofing it to be impregnated with gold; nay, we are informed by Neumann, that not only the cinnabar, antimony, and copper of Hungary, but even the vine trees of that country were thought to be impregnated with the precious metal. Not many years ago a French chemift advertifed that he had obtained a confiderable quantity of gold from the afhes of vine twigs and ftems, as well as of the garden foil where they grew; but the falfehood of thefe affertions was demonftrated by the count de Lauragais to the fatisfaction of the Royal Academy of Sciences.

The reduction of mercury into a folid ftate, fo that it might be employed like filver, was another favourite alchemical purfuit. But all proceffes and operations of this kind, fays Neumann, if they have mercury in them, are no other than hard amalgams. When melted lead or tin are juft becoming confiftent after fufion, if a ftick be thruft into the metal, and the hole filled with quickfilver, as foon as the whole is cold, the mercury is found folid. Macquer informs us, that mercury becomes equally folid by being expofed to the fumes of lead. Maurice Hoffman, as quoted by Neumann, even gives a procefs for reducing mercury, thus coagulated, to a ftate of malleability, viz. by repeatedly melting and quenching it in linfeed oil. Thus, he tells us, we obtain a metal which can be formed into rings and other utenfils. But here the mercury is entirely diffipated by the repeated fufions, and nothing but the original lead is left. Wallerius, after mentioning ftrong foap-leys, or cauftic lixivium, and fome other liquors proper for fixing quickfilver, tells us, that by means of a certain gradatory water, the compofition of which he learned from Creuling *de Aureo Vellere*, he could make a coagulum of mercury whenever he pleafed, of fuch confiftency that great part of it would refift cupellation; but what this gradatory water was, he has not thought proper to lay before the public.

2. Native precipitate *per fe*, in which the metal is mineralized by aerial acid. This was lately found in Idria, in hard compact maffes of a brownifh red colour and granular texture, mixed with fome globules of native mercury. An hundred parts of it afford 91 of running mercury.

Various little globules of mercury were contained in this ore, which are rendered very vifible by being heated, but are foon reabforbed by cooling. On expofing it to the fire in an iron fpoon, the red colour foon became more vivid, but turned yellowifh on cooling. Diftilled in a pneumonic apparatus, a quantity of dephlogifticated air was produced, though lefs by one fourth than what fhould have been produced by an equal quantity of cinnabar. On diftilling an ounce of this ore in a glafs retort, a little yellow powder was left, which weighed a fourth part of a grain, and ftained the bottom of the retort in a manner fimilar to what is done by the calx of filver to white glafs in fimilar circumftances. On cupelling this powder with 144 grains of lead wrapped up in paper, the increafed weight of the lead over that of the teft of comparifon fhowed that the calx was reduced into its metallic ftate of filver and mixed with that of lead.

3. Mineralifed by the vitriolic and marine acids. This kind of ore was firft difcovered in the year 1776, at Obermofchal in the duchy of Deux Ponts. It has a fpar-like appearance, and is either bright and white, or yellow or black, and mixed with cinnabar in a ftony matrix. The native marine falt of mercury is in the ftate of corrofive fublimate.

4. Native cinnabar, in which the metal is mineralifed by fulphur. This is of different fhades from a yellowifh to a deep red; and is found either pure in hard friable maffes, either fhapelefs or cryftallized in cubes, and fometimes tranfparent, or intermixed with clay or ftone, or interfperfed through the ores of other metals, particularly thofe of filver, copper, or martial pyrites. Its texture is either radiated, ftriated, fcaly, or granular. An hundred parts of cinnabar contain about 80 of mercury and 20 of fulphur; but artificial cinnabar contains a little more fulphur, and hence its colour is darker. Its fpecific gravity is about 7.000; it fublimes in clofe veffels, and is decompofed and volatilized in open ones. It is found in the duchy of Deux Ponts, in the Palatinate, in Hungary, Friuli, and Almaden in Spain, and in South America, efpecially at Guancavelica in Peru. It is fometimes compact, and fometimes found in tranfparent, ruby-coloured cryftals, and often in a kind of fcales or flattened laminæ. It is called native vermilion, and cinnabar in flowers, when it is in the form of a very bright red powder. It is alfo found in different earths, in felenite mixed with iron, with pyrites, and

Quick-silver.

and with sulphur. Mr Fourcroy enumerates the following varieties: 1. Transparent cinnabar, red and crystallized in very short triangular prisms, terminated by triangular pyramids. 2. Transparent red cinnabar, in octohedral crystals, consisting of two triangular pyramids united at their bases and truncated. 3. Solid compact cinnabar, of a brown or bright red; it is sometimes foliated. 4. Red cinnabar distributed in striæ, on a stony matrix, or on solid cinnabar. It is sometimes composed of needles like cobalt. 5. Cinnabar in flowers, or native vermilion. It is of a bright red colour, and sattin appearance, adhering to different matrices, in form of a very fine powder. It is sometimes crystallized in very small needles, and then greatly resembles the foregoing.

The finer coloured ores of mercury are never worked for extracting the metal, but used entirely as pigments; but they have been very injudiciously preferred for medicinal uses to the more pure factitious cinnabars; for we seldom meet with any native cinnabar that has not some earthy or stony matter intermixed with it, nor with two pieces that perfectly agree. There are three varieties principally distinguished in the shops; viz. 1. Cinnabar in masses weighing from one to six ounces or more. 2. In grains, prepared by breaking the worse coloured masses, and picking out the best coloured bits. 3. Washed cinnabar, prepared by washing over the lighter impurities that are to be found in it. No native cinnabar should ever be employed in medicine without being previously purified by sublimation. Neumann informs us that he never met with any native cinnabar which did not leave a grey ash or sand, amounting, among different parcels, from one ninth to one fifth of the mineral employed. The residuum had no gold in it, though the colour of its solution and precipitate gave some expectation of it at first sight.

Neumann remarks, that though vitriolic acid forms with mercury a lively yellow concrete, viz. turbith mineral, and with the inflammable principle a yellow sulphur; and though sulphur itself forms with mercury a beautiful red cinnabar; yet the same vitriolic acid destroys the red colour entirely, rendering it as white as milk. This change is not immediately produced on common cinnabar by the vitriolic acid; but, on being digested over a strong sand heat in a glass cup, it soon becomes as white as cream; and the vitriolic acid takes the form of a strong sulphureous and volatile vapour, very suffocating and corrosive; emitting very piercing fumes for some time, which turned the paper that covered it black, and destroyed its texture.

5. Black ore of mercury, in which the metal is mineralized by sulphur and copper. This is of a blackish grey colour, a glassy texture, brittle, heavy, and decrepitating strongly when heated. It is found at Muschel Lansberg. An ore of this kind is also found in the duchy of Deux Ponts. In the sulphur of Idria a black cinnabar is likewise said to be found, which retains its colour in sublimation; but this is not yet sufficiently confirmed, though it is too bold an assertion of Dr J. R. Forster that no such cinnabar has ever been found. He adds, that a certain learned man thought he had discovered some near the copper ores at Lauterberg; but that it proved to be a red copper calx, which is still to be met with in that place.

6. Pyritous mercurial ore was brought from Dauphiny by Mr Montigny in 1768. It is grey, whitish, and friable. An hundred parts yielded one of mercury, one half of silver, the remainder being iron, cobalt, sulphur, and arsenic.

7. An ore of mercury, in which the metal is mineralized with iron by sulphur, is mentioned by Sir Torbern Bergman in his *Sciagraphia*, sect. 177. He says that it is doubtful whether this does not belong to the species of cinnabar, as the iron is perhaps only mechanically diffused thereon. Mr Mongez informs us, that there are but few instances of cinnabar in which iron is not found in its calcined form, though, in the act of the ore being reduced, it passes to its metallic state, and becomes capable of being acted upon by the loadstone.

Another pyritous ore of cinnabar was found at Menidot, near St Lo in Lower Normandy. It consisted of differently sized grains of a red brown colour: they had a vitriolic taste and sulphureous smell. Pyritous ores of this kind are likewise found at Almaden in Spain, and at Stahlberg in the Palatinate. The cinnabaric pyrites of this last place are of a dodecaedral form.

8. Mr Gellert informs us, that an ore of quicksilver is met with in Idria, where the mercury lies in an earth or stone, as if it were in a dead form; and has the appearance of a red-brown iron-stone, but much heavier. It contains from three quarters to seven-eighths of the purest mercury, leaving after distillation a very black strong earth, giving also some marks of cinnabar. For, as we do not know the ultimate divisibility of mercury, we cannot justly determine the point of its fluidity, although its globules may be no more discernible.

The *liver-ore*, which is most common in Idria, and has its name from its colour, resembles an indurated iron-clay; but its weight discovers it to have metallic contents. An hundred weight of it sometimes yields 80 pounds of quicksilver.

The *brand-erz*, or burning ore of the Germans, likewise belongs to this species. It may be lighted at a candle, and yields from 9 to 50 pounds of metal in the 100.

9. Dr Gmelin informs us, that cinnabar mixed with arsenic or realgar is said to be found in Japan; and that at Morsfield the cinnabar and white calx of arsenic present themselves in the same rock.

10. Besides the ores already mentioned, we sometimes meet with quicksilver natively amalgamated with gold, silver, and other metals. This is taken notice of by Bergman; and from the authorities of Monet and Prof. Gmelin, Mr Kirwan informs us, that in Sweden and Germany this metal has been found united to silver in an hard and brittle amalgam. M. de L'Isle had a specimen of this ore from Germany; which, as M. Mongez informs us, is imbedded in a quartzose mass, and mixed with cinnabar. A specimen brought from the mine called *Carolina*, in a crystalline form, was deposited in the royal cabinet at the king's garden at Paris. M. de L'Isle likewise informs us, that a specimen of native gold was brought from Hungary, which, according to Cronstedt, was probably an amalgam of mercury and gold. It is composed of quadrangular prisms, of a greyish yellow colour, and brittle texture. Neumann likewise observes, that sometimes a mineral,

containing gold or silver, is met with among mercurial ores, though very rarely.

These natural amalgams account for the great specific gravity of some kinds of quicksilver. This may proceed from a natural mixture of gold, though, according to Boerhaave, it may also arise from its being redistilled a great number of times. By a similar mode of reasoning we may conclude, that the smallest specific gravities of quicksilver proceed from its amalgamation with silver, lead, and other metals or semimetals, which in spite of repeated distillations may still preserve their union with it; for Dr Boerhaave informs us that he could not, by any number of distillations, free mercury perfectly either from tin or lead.

M. Magellan, in his notes on Cronstedt's Mineralogy, says, "That mercury is many times found amalgamated with lead, is easily evinced by the process of M. Grosse mentioned by Macquer in his elements of Chemistry, where the method of extracting mercury from some solutions of lead is described; but the same Macquer, in his Chemical Dictionary, positively affirms, that, though Beccher and Kunckel have both given other processes for extracting mercury from lead, and though the method pointed out by M. Grosse is easier than the others, nevertheless it does not succeed if the lead be quite pure without any amalgamation with mercury. And Boerhaave has expressly made the same assertion, complaining of those authors who affirm the contrary." Dr Black, however, seems to be of a different opinion; and, in his public course of lectures, teaches that, "by some processes of the more difficult kind, mercury may be extracted from lead;" though he cautions us, at the same time, not to infer from this, or any other chemical process, the possibility of the transmutation of metals.

Mercury is not in any way altered by the action of light. Its dilatation by heat is extremely regular, as has lately been shown, in a very great variety of experiments, by Dr Adair Crawford; for which reason it is used as the measure of heat, and thermometers are usually filled with this metal. When opposed to the heat of about 600° of Fahrenheit, it boils and is dispersed in an invisible fume; which, however, has been observed to have the elasticity of the steam of water, and to burst an iron box in which it was attempted to confine it. If it be made to boil in a close vessel fitted with a proper apparatus, it will all come over in its proper form, and leave any fixed matter it might contain in the retort. This affords an easy method of purifying it from the base metals with which it is frequently adulterated; though even in this way it is necessary to raise the fire cautiously, or a part of the fixed metal will be carried up along with the mercury. And even with all the care that can be taken, it has been found impossible, as has been already said, to free it perfectly from a mixture of the base metals by any number of distillations.

By a very great number of distillations, however, it was said that some change might be made upon this metal; and that it became not only purer, but specifically *heavier*, by such an operation. Boerhaave, after making it undergo this operation 511 times, found some difference; but three years after, in a Memoir inserted in the Philosophical Transactions for 1736, he acknowledged, that, on repeating the operation 877 times, its specific gravity, as shown by Dr Gravesande's nice hydrostatic balance, appeared to be no more than 13.500 to distilled water.

Quicksilver.

"Boerhaave died (says Mr Magellan in his Notes on Cronstedt's Mineralogy) two years after, on the 23d of September 1738; and left his papers to his two nephews, Herman, who died the 7th of October 1753, and Kaw, who died five years after. On their deaths the manuscripts fell into the hands of Charles Frederick Kruse physician to the Emperor of Russia. This gentleman published a short extract from Boerhaave's Diary in the ninth volume of the *Novi Commentarii* of the Imperial Academy of Petersburg, of which the following are the results.

"The specific gravity of the purest gold to that of distilled water is - - 19,024

That of mercury distilled once in a retort	13,570
Distilled 1009 times - -	13,590
Once from its amalgam with gold -	13,550
750 times from the same amalgam -	13,520
877 times from the same - -	13,500
Once from its amalgam with silver -	13,550
217 times from the same amalgam -	13,500

"It is evident, therefore, by these facts, that mercury does not acquire any additional increase to its specific gravity by the mere repetition of simple distillations, nor by its amalgamations with gold or silver, provided it be afterwards properly separated by fire."

It is certain, however, that there are very considerable differences in the specific gravity of different specimens of quicksilver; and authors have by no means agreed in fixing the standard.—Bergman states it at 14.110; and Muschenbroek asserts that such was the specific gravity of Boerhaave's quicksilver that had been distilled 511 times: but some modern authors, among whom is M. Fourcroy, state the specific gravity of this metal at no more than 13.000. Modern experiments, however, show that it is generally about 13.500 or 13.600. "This (says Mr Magellan) I am informed was the mean specific gravity found by the late Lord Cavendish, after the repeated and nice trials he made upon 50 different specimens of quicksilver, on which he employed all his industry and attention to determine this point.

"The hydrostatical experiments I lately undertook of this kind upon ten different specimens of mercury, two of which were revived from natural and artificial cinnabar by the operator of Mr Kirwan, confirmed me in the same opinion.

"The temperature of the atmosphere was nearly the mean, viz. at the 50th degree of Fahrenheit's thermometer; and the scales employed were so nice, that they turned with the hundredth part of a grain when loaded with four pounds weight.—The method made use of to ascertain these specific gravities is the easiest of all. A phial of white glass with a ground stopple was counterbalanced with lead or other matter in a nice pair of scales. The substance to be tried was introduced into the phial and weighed together, and the weight we suppose $= a$. The remaining space of the phial being then filled with distilled water, we suppose the weight now to be $= b$. Lastly, the phial was filled with distilled water, and the weight supposed $= c$. It is evident,

Quick-silver.

dent, that $b - a = d$, the quantity of water in the second operation; $c - d = e$, the water whofe bulk is equal to that of the fubftance; and that $\frac{a}{e}$ is the fpecific gravity fought for.—Particular care was taken that no bubble of air remained in the infide. For this purpofe a very fmall groove was made with a file on the infide of the glafs ftopper; and this was introduced fidewife without admitting any air, leaving the fuperfluous water to rufh out.

"The greateft fpecific gravity of any of thofe fpecimens was 13.620, and the leaft 13.450. The heavieft was neither of the two that had been diftilled from cinnabar, but a common quickfilver bought at Apothecaries Hall, London; and the lighteft was taken from a barometer of the beft and deareft kind made by one of the moft reputed inftrument-makers in England.

"The moft obvious caufe of this difference of fpecific gravity in quickfilver feems to be its mixture or amalgamation with other metals. Certainly, when united to gold, its gravity muft of courfe be fpecifically augmented: on the contrary, it muft be leffened when united with any other metal, platina only excepted; and the fame muft be the cafe whether water or any other moifture is mixed with it; for in fuch a cafe the metal will be found heavier after evaportion. A fimple boiling of the quickfilver over the fire in an open veffel will completely free it from this mixture; and no careful maker of experiments fhould neglect the preparation before he undertakes to employ mercury in any procefs, or for any purpofe of the philofophic kind. The boiling muft be continued for 20 or 30 minutes in order to expel the whole moifture.

Another caufe by which the fpecific gravity of quickfilver becomes fubject to alteration is the difference of temperature of the atmofphere at the time of making the experiment. Nor is it quickfilver alone, but every other fubftance whofe fpecific gravity is affected by this caufe in a greater or leffer degree; infomuch that Mr Magellan does not hefitate to pronounce the labours of all thofe who have undertaken to compofe tables of fpecific gravities, without regard to this circumftance, to be, if not entirely ufelefs, at leaft incapable of affording proper fatisfaction in the nice inquiries that depend on this knowledge.

In Eifenchmid's table of fpecific gravities it is afferted, that a cubic inch of mercury in fummer weighs feven ounces, one gros, 66 grains; but in winter it weighs 20 grains more: the whole weight then being feven ounces, two gros, 14 grains (allowing 72 grains to the gros). This, however, leaves the matter almoft in as great uncertainty as before; the fummer and winter temperature being widely different in different places, and very often even in the fame place. Unlefs therefore the temperature of the air is attended to at every experiment in taking the fpecific gravity of any fubftance whatever, there can be no certainty of the refult.

Quickfilver always feels cold when touched in the common temperature of the atmofphere. Our fenfations, according to Fourcroy, deceive us in this cafe, for a thermometer dipped in quickfilver always fhows the common temperature. "The great continuity of contact between the live fkin and numerous metallic particles in an equal fpace, and which are proportional to its great fpecific gravity, neceffarily produces a ftronger fenfation of its own temperature, this being always much lefs than that of a living body; and the multiplicity of thefe points of contact being all at once applied to this organ of fenfation, muft be more powerfully felt than whenever we touch any other matter that is lighter in itfelf, or of a lefs denfity."

Notwithftanding this apparent coldnefs, however, quickfilver, when expofed to the fame degree of heat, and in the fame circumftances with various other fubftances, foon becomes hotter to the touch than any of them. "The fundamental principle of this (fays Mr Magellan) confifts in the fmall quantity of fpecific fire, or the lefs capacity which mercury is endowed with of receiving heat. This is fuch, that, compared with the capacity of water for the fame purpofe, it is in the ratio of 0.033 to 100, as appears by the table of the quantities of fpecific fire contained in various bodies.—This table, publifhed in Magellan's Effay on Elementary Fire, was grounded upon various important experiments and obfervations made by Mr Kirwan, in confequence of the new Theory of Fire difcovered by Dr Crawford. Hence it follows, that if equal quantities of heat be communicated to equal quantities of water and mercury, the latter will have a temperature 30 times greater than that of the water; that is to fay, in the inverfe ratio of their refpective capacities, or as 1 to 30 (=0.033 : 1.000), in the fame manner as it muft happen, when equal meafures of corn or of any fluid are thrown into veffels whofe bottoms are as 30 to 1; for then their heights muft neceffarily be in their inverfe ratio, viz. of 1 to 30, &c. See CHEMISTRY, n° 1225, &c.

Quickfilver does not appear to diffolve in water; but Fourcroy remarks, that phyficians are in the practice of fufpending a bag full of it in vermifuge ptifans during their ebullition, and that experience has evinced the good effects of it. Lemery afferts, that in this procefs there is no lofs of weight; but this is denied by others. Fourcroy afferts, that this metal, rubbed between the fingers, emits a perceptible odour, though Magellan fays he tried the experiment many times without fuccefs.

Fourcroy likewife afferts, that mercury when pure emits a phofphoric light by agitation, particularly in hot feafons. This phenomenon has certainly been obferved in the mercury of the barometer; but its appearance on other occafions refts entirely on the authority of Mr Fourcroy. Even in the barometer it does not take place, unlefs the Torricellian vacuum be not perfectly made in the fpace at the top of the tube. Phials of glafs nearly exhaufted of air, and containing fome quickfilver hermetically fealed up, will, on being fhaken, produce as much light in the dark as is fufficient to fhow the hour on the dial-plate of a watch. But if a perfect vacuum be produced by nicely boiling the quickfilver within the glafs, no appearance of this kind is to be perceived. The phenomenon is certainly of the electrical kind; and its not appearing in the perfect vacuum is owing to the difficulty there is in fetting in motion any large quantity of electric matter by itfelf, which indeed can fcarce be done without producing very violent effects. See *ELECTRICITY Index*.

Mercury unites with all the metals and femimetals, excepting iron and regulus of antimony. Thefe compounds are called *amalgams;* and Mr Machy has obferved,

Quick-filver. ferved, that in forming them a certain degree of cold is produced. He made the experiment by covering the ball of a thermometer with tin-foil, and then dipping it into quickfilver; upon which that in the thermometer fell fome degrees: which agrees perfectly well with the doctrine of latent heat firft difcovered by Dr Black, as it fhows that in this, as well as other cafes, where a body paffes from a folid into a fluid ftate, a degree of cold is produced.—The following obfervations on the amalgams of mercury with different metals are extracted from the Memoirs of the Academicians of Dijon.

1. The amalgam of gold and mercury cryftallizes into quadrangular pyramids. Six ounces of mercury are retained by one of gold in this cryftallization; but that with filver retains a third part more of quickfilver.

2. The amalgam with filver is likewife fufceptible of cryftallization, and affumes the form of a tree; every ounce of filver retaining eight of mercury. This amalgam, by means of the nitrous acid, well freed from the vitriolic by folution of filver in the fame, forms that curious kind of vegetation mentioned in the article CHEMISTRY, n° 754, called *Arbor Dianæ*, or *Arbor Philofophorum*.—The following is recommended by Mr Magellan as the fhorteft procefs:

"Diffolve 228 grains of filver, and half as much quickfilver, in pure nitrous acid. Add to the folution, when made, five ounces (of 576 grains each) of diftilled water. Put this folution into a fpherical veffel of white glafs, at the bottom of which muft already be put 432 grains of an amalgam of filver of the confiftence of butter: let the veffel be kept in a quiet place, free from any fhaking or external agitation; and at the end of fome few hours the figure of a bufh or tree of filver will be formed within the water of the glafs veffel. The metals contained in the folution and in the amalgam attract each other, and a number of fmall tetrahedral cryftals are formed, which lay hold at one another's end, and form the appearance of a vegetation.

3. Copper is amalgamated with mercury with great difficulty, and only by mixing blue vitriol with mercury and water in an iron retort over the fire. The acid then attacks the veffel, and the copper is precipitated in a metallic ftate, which, by ftirring it with an hot iron fpatula, unites to the mercury, but does not cryftallize.

4. Two ounces of melted lead poured on a pound of mercury produce a half fluid amalgam, which being decanted gives fome cryftals like thofe of filver. One ounce of thefe cryftals retains an ounce and an half of mercury.

5. The amalgam of tin cryftallizes into thin fhining lamellæ, with polygonous cavities between one another. Two ounces of tin retain fix of mercury in this cryftallization.

6. Mercury amalgamates with bifmuth by means of heat, and produces cryftals of an octohedral form, and lamellated triangles and hexagons. They are black on the upper furface, and fhining underneath. In this cryftallization the bifmuth retains double its weight of mercury.

7. *Zinc*, in fufion, poured upon mercury, produces a crackling noife refembling that produced by a hot body thrown into boiling water. It cryftallizes very well into lamellated hexagonal figures, leaving cavities among themfelves. One ounce of zinc retains two and an half of mercury in this cryftallization.

8. *Quickfilver* does not amalgamate with arfenic, except by heat, and then only in very fmall quantity. This metal anfwers very important purpofes both in medicine and the arts. Though it has no perceptible tafte, it produces very remarkable effects on the ftomach and inteftines of animals, as well as on the furface of the fkin. Infects and worms are extremely fenfible of this effect, and the metal, almoft in any ftate, is exceedingly pernicious to them. Phyficians, therefore, employ it as an excellent vermifuge (fee MEDICINE, p. 341.), and it is likewife one of the moft powerful remedies in the materia medica for many obftinate diforders befides thofe of the venereal kind, in which its efficacy has long been celebrated. "Even the moft virulent product of mercury (fays Mr Magellan), known by the name of fublimate corrofive, which is the moft violent poifon, is often taken internally in very minute dofes, under the direction of fkilful phyficians, and produces the moft happy effects in a great variety of cafes even of the moft defperate kind. This is a fact which I have experienced myfelf, in a dreadful fcorbutic complaint which I fuffered for above four years, with reftlefs and violent pains in the eyes and head. None of the moft able phyficians in London and Paris I confulted afforded me any effectual relief, till I had the good fortune to confult Mr Sacre furgeon-oculift at Antwerp. His prefcription confifted of three grains of fublimate diffolved in a pint of common proof fpirit. The dofe confifted in taking every morning two fpoonfuls of it in a pint of new milk. In lefs than two months I began to feel relief; and in three months time was completely cured. The firft methodical practice of this remedy was communicated to the celebrated Van Swieten, firft phyfician to the Emperor's court, by the late Dr A. R. Sanches, then chief phyfician to the court of Peterfburg, as appears by the laft volume of the Commentaries of the fame Van Swieten, publifhed in 1772. This volume was publifhed after the author's death; but he had enjoyed during his life the glory of being the author of this wonderful remedy, which continues to bear his name among *the ignorant and inaccurate phyficians* of our times."

But whatever ufes this falt may be put to when taken in fmall quantities, it is certainly not lefs violent than arfenic itfelf, if taken in a large dofe; and the danger is the greater, on account of the difficult folution of the falt, which requires for this purpofe 19 times its weight of water. Alkaline falts, however, prove a very effectual antidote, and will inftantly relieve the fymptoms; but, on account of the infolubility of the poifonous falt, the diforders occafioned by it foon return, and require a repetition of the fame remedy. In cafes where alkaline falts are not immediately at hand, foap diffolved in water will anfwer the fame purpofe; or if this alfo fhould not be inftantly procureable, chalk, lime, fpirit of hartfhorn, or magnefia alba, might be ufed with good effect.

Quickfilver is employed in Chili and Peru to extract gold and filver, when native, from the earthy matters with which they are mixed. The principle on which this method is founded is the ftrong mutual attraction betwixt mercury and the precious metals. By reafon of this the fmalleft particles either of gold or filver form an amalgam with the mercury, part of which is ftrained off, and the remainder either feparated by diftillation

ſtillation in iron retorts, or by a kind of diſtillation *per deſcenſum*; putting it in a kind of metallic ſieve over a veſſel of water, to receive the mercury, which is driven down by a fire lighted in a veſſel above the amalgam.

The amalgam with gold ſerves alſo to gild copper or ſilver, ſo that they appear as if made of ſolid gold.—For this purpoſe the pieces are to be well cleaned, and then dipped in a weak aquafortis; then in a nitrous ſolution of quickſilver, which covers them with a kind of ſilvering. After this the amalgam of gold is very equally ſpread over them; which being done, the piece is expoſed to a heat ſufficient to volatilize the quickſilver, and the gold is then left ſtrongly adhering to the metal. The only uſe to which the amalgam of mercury with lead has hitherto been applied, is the luting glaſs veſſels in which ſpecimens of natural hiſtory are to be preſerved in ſpirit of wine. For this it is more proper than any other ſubſtance, having an excellent effect in preventing evaporation. The amalgam of tin is commonly employed in making looking-glaſſes or mirrors. The thin ſheet of tin is laid down on a large flat table of ſtone; a proper quantity of mercury, in which ſome tin has already been diſſolved to prevent it from deſtroying the tin ſheet, is rubbed over with a bunch of cloth like a flat bung, and the glaſs carefully ſlided upon it from one end to the other, in ſuch a manner that the dirty cruſt of the quickſilver is driven off before its edge; and the glaſs is then loaded with weights all over: by inclining gradually the ſtone table, the ſuperfluous mercury is diſcharged; and in a few hours both cohere together. This amalgam is uſed for exciting the electricity of glaſs globes in the common electrical machines, but is ſaid to be inferior in ſtrength to that made with zinc.

Quickſilver heated by itſelf, with acceſs of air, is by degrees converted into a red powder, improperly called *Mercurius precipitatus per ſe*. It conſiſts of the calx of the metal united with the baſis of dephlogiſticated or pure air, which may be expelled from it again by a ſtrong heat; and this was the firſt method by which Dr Prieſtley obtained this kind of air.

Mercury is not altered by the contact of air: It is only obſerved, that it becomes tarniſhed by the particles of duſt which the air depoſits; and from that circumſtance mercury has been called the loadſtone of duſt.—Though all bodies have this property, it ſeems more remarkable in mercury than any other, on account of its great ſplendour; but it is not in the leaſt changed by this circumſtance, nothing more being neceſſary to reſtore it to its original brilliancy than filtration through a piece of ſhamoy leather.

The volatility of mercury prevents it from uniting with earths in the way of fuſion; though M. Fourcroy is of opinion that its red calx, or precipitate *per ſe*, might perhaps fix in glaſſes, and colour them, as is obſerved in the calx of arſenic.

QUICK-MATCH, among artillery men, a kind of combuſtible preparation formed of three cotton ſtrands drawn into length, and dipped in a boiling compoſition of white-wine vinegar, ſaltpetre, and mealed powder. After this immerſion it is taken out hot, and laid in a trough where ſome mealed powder, moiſtened with ſpirits of wine, is thoroughly incorporated into the twiſts of the cotton, by rolling it about therein. Thus prepared, they are taken out ſeparately, and drawn through mealed powder; then hung upon a line and dried, by which they are fit for immediate ſervice.

QUID PRO QUO, in law, *q. d.* "what for what," denotes the giving one thing of value for another; or the mutual conſideration and performance of both parties to a contract.

QUID *pro quo*, or QUI *pro quo*, is alſo uſed in phyſic to expreſs a miſtake in the phyſician's bill, where *quid* is wrote for *quo*, i. e. one thing for another; or of the apothecary in reading *quid* for *quo*, and giving the patient the wrong medicine. Hence the term is in the general extended to all blunders or miſtakes committed in medicine, either in the preſcription, the preparation, or application of remedies.

QUIDDITY, QUIDDITAS, a barbarous term uſed in the ſchools for *eſſence*. The name is derived hence, that it is by the eſſence of a thing that it is *tale quid*, ſuch a *quid*, or thing, and not another. Hence what is eſſential to a thing is ſaid to be *quiddative*.

QUIETISTS, a religious ſect, famous towards the cloſe of the laſt century. They were ſo called from a kind of abſolute reſt and inaction, which they ſuppoſed the ſoul to be in when arrived at that ſtate of perfection which they called the *unitive life*; in which ſtate they imagined the ſoul wholly employed in contemplating its God, to whoſe influence it was entirely ſubmiſſive; ſo that he could turn and drive it where and how he would. In this ſtate, the ſoul no longer needs prayers, hymns, &c. being laid, as it were, in the boſom and between the arms of its God, in whom it is in a manner ſwallowed up.

Molinos, a Spaniſh prieſt, is the reputed author of Quietiſm; though the Illuminati in Spain had certainly taught ſomething like it before. The ſentiments of Molinos were contained in a book which he publiſhed at Rome in the year 1681, under the title of the *Spiritual Guide*; for which he was caſt into priſon in 1685, and where he publicly renounced the errors of which he was accuſed. This ſolemn recantation, however, was followed by a ſentence of perpetual impriſonment, and he died in priſon in the year 1696. Molinos had numerous diſciples in Italy, Spain, France, and the Netherlands. One of the principal patrons and propagators of Quietiſm in France was Marie Bouvieres de la Mothe Guyon, a woman of faſhion, remarkable for goodneſs of heart and regularity of manners; but of an unſettled temper, and ſubject to be drawn away by the ſeduction of a warm and unbridled fancy. She derived all ideas of religion from the feelings of her own heart, and deſcribed its nature to others as ſhe felt it herſelf. Accordingly, her religious ſentiments made a great noiſe in the year 1687; and they were declared unſound, after accurate inveſtigation, by ſeveral men of eminent piety and learning, and profeſſedly confuted, in the year 1697, by the celebrated Boſſuet. Hence aroſe a controverſy of greater moment between the prelate laſt mentioned and Fenelon archbiſhop of Cambray, who ſeemed diſpoſed to favour the ſyſtem of Guyon, and who in 1697 publiſhed a book containing ſeveral of her tenets. Fenelon's book, by means of Boſſuet, was condemned in the year 1699, by Innocent XII. and the ſentence of condemnation was read by Fenelon himſelf at Cambray, who exhorted the people to reſpect and obey the papal decree.

Notwithstanding this seeming acquiescence, the archbishop persisted to the end of his days in the sentiments, which, in obedience to the order of the pope, he retracted and condemned in a public manner.

A sect similar to this had appeared at Mount Athos in Thessaly, near the end of the 14th century, called *Hesychasts*, meaning the same with Quietists. They were a branch of the mystics, or those more perfect monks, who, by long and intense contemplation, endeavoured to arrive at a tranquillity of mind free from every degree of tumult and perturbation. In conformity to an ancient opinion of their principal doctors (who thought there was a celestial light concealed in the deepest retirements of the mind), they used to sit every day, during a certain space of time, in a solitary corner, with their eyes eagerly and immoveably fixed upon the middle regions of the belly or navel; and boasted, that while they remained in this posture, they found, in effect, a divine light beaming forth from their soul, which diffused through their hearts inexpressible sensations of pleasure and delight. To such as inquired what kind of light this was, they replied, by way of illustration, that it was the glory of God, the same celestial radiance that surrounded Christ during his transfiguration on the Mount. Barlaam, a monk of Calabria, from whom the Barlaamites derived their denomination, styled the monks who adhered to this institution *Massalians* and *Euchites;* and he gave them also the new name of *Umbilicani*. Gregory Palamas, archbishop of Thessalonica, defended their cause against Barlaam, who was condemned in a council held at Constantinople in the year 1341.—See *Fenelon's Max. des Saints.*

The Mahometans seem to be no strangers to quietism. They expound a passage in the 17th chapter of the Koran, viz. "O thou soul which art at rest, return unto thy Lord, &c." of a soul which, having, by pursuing the concatenation of natural causes, raised itself to the knowledge of that being which produced them, and exists of necessity, rests fully contented, and acquiesces in the knowledge, &c. of him, and in the contemplation of his perfection.

QUILLET (Claude), an eminent Latin poet of the 17th century, was born at Chinon, in Touraine, and practised physic there with reputation: but having declared against the pretended possession of the nuns of Loudun, in a manuscript treatise, the original of which was deposited in the library of the Sorbonne, he was obliged to retire into Italy, where he became secretary to the marshal d'Estrees, the French ambassador at Rome. In 1655 Quillet having published in Holland a Latin poem, entitled *Callipædia*, under the name of *Galvidius Lætus*, he there inserted some verses against the cardinal Mazarine and his family; but that cardinal making him some gentle reproaches, he retrenched what related to the cardinal in another edition, and dedicated it to him, Mazarine having, before it was printed, given him an abbey. He died in 1661, aged 59, after having given Menage all his writings, and 500 crowns to pay the expence of printing them; but the abbé took the money and papers, and published none of them. His *Callipædia*, or the art of getting beautiful children, has been translated into English verse.

QUILLS, the large feathers taken out of the end of the wing of a goose, crow, &c. They are denominated from the order in which they are fixed in the wing; the second and third quills being the best for writing, as they have the largest and roundest barrels. Crow-quills are chiefly used for drawing. In order to harden a quill that is soft, thrust the barrel into hot ashes, stirring it till it is soft, and then taking it out, press it almost flat upon your knee with the back of a penknife, and afterwards reduce it to a roundness with your fingers. If you have a number to harden, set water and alum over the fire, and while it is boiling put in a handful of quills, the barrels only, for a minute, and then lay them by.

QUIN (James), a celebrated performer on the English stage, was born at London in 1693. He was intended for the bar; but preferring Shakespeare to the statutes at large, he on the death of his father, when it was necessary for him to do something for himself, appeared on the stage at Drury-lane. In 1720, he first displayed his comic powers in the character of Falstaff, and soon after appeared to as great advantage in Sir John Brute; but it was upon Booth's quitting the stage that Quin appeared to full advantage, in the part of Cato. He continued a favourite performer until the year 1748, when, on some disgust between him and Mr Rich the manager, he retired to Bath, and only came up annually to act for the benefit of his friend Ryan; until the loss of two front teeth spoiled his utterance for the stage. While Mr Quin continued upon the stage, he constantly kept company with the greatest geniuses of the age. He was well known to Pope and Swift; and the earl of Chesterfield frequently invited him to his table: but there was none for whom he entertained a higher esteem than for the ingenious Mr Thomson, to whom he made himself known by an act of generosity that does the greatest honour to his character; and for an account of which see our life of THOMSON. Mr Quin's judgment in the English language recommended him to his royal highness Frederick prince of Wales, who appointed him to instruct his children in speaking and reading with a graceful propriety; and Quin being informed of the elegant manner in which his present majesty delivered his first gracious speech from the throne, he cried out in a kind of ecstasy, "Ay—I taught the boy to speak!" Nor did his majesty forget his old tutor; for, soon after his accession to the throne, he gave orders, without any application being made to him, that a genteel pension should be paid to Mr Quin during his life. Mr Quin, indeed, was not in absolute need of this royal benefaction; for as he was never married, and had none but distant relations, he sunk 2000 l. which was half his fortune, in an annuity, for which he obtained 200 l. a-year; and with about 2000 l. more in the funds, lived in a decent manner during the latter part of his life at Bath, from whence he carried on a regular correspondence with Mr Garrick, and generally paid a visit to his friends in the metropolis once a year, when he constantly passed a week or two at Mr Garrick's villa at Hampton. He died of a fever in 1766.

QUINARIUS, was a small Roman coin equal to half the denarius, and consequently worth about three pence three farthings of our money. See MONEY.

It was called *quinarius*, becaufe it contained the value of five affes, in the fame manner as the denarius was named from its containing ten.

QUINAUT (Philip), a celebrated French poet, born of a good family at Paris in 1635. He cultivated poetry from his infancy, and 16 dramatic pieces of his were acted between the year 1653 and 1666. In the mean time, Quinaut was not fo much devoted to poetry but that he applied himfelf to the ftudy of the law; and made his fortune by marrying the widow of a rich merchant to whom he had been ufeful in his profeffion. Quinaut afterwards turned his attention to the compofing of operas, which were fet to mufic by the famous Lully; and Lully was charmed with a poet whofe verfes were not too nervous to yield to the capricious airs of mufic. He died in 1688, after having enjoyed a handfome penfion from Louis XIV. for many years: and we are told he was extremely penitent in his laft illnefs for all thofe of his compofitions which tended to infpire love and pleafure.

QUINCE, in botany. See CYDONIA.

QUINCUNX, in Roman antiquity, denotes any thing that confifts of five-twelfths of another; but particularly of the *as*.

QUINCUNX *Order*, in gardening, is a plantation of trees, difpofed originally in a fquare confifting of five trees, one at each corner, and a fifth in the middle; which difpofition, repeated again and again, forms a regular grove, wood, or wildernefs.

QUINDECAGON, in geometry, a plain figure with 15 fides and 15 angles.

QUINDECEMVIRI, in Roman antiquity, a college of 15 magiftrates, whofe bufinefs it was to prefide over the facrifices. They were alfo the interpreters of the Sybil's books; which, however, they never confulted but by an exprefs order of the fenate.

QUINQUAGENARIUS, in Roman antiquity, an officer who had the command of 50 men.

QUINQUAGESIMA SUNDAY, Shrove Sunday, fo called as being about the 50th day before Eafter.

QUINQUATRIA, or QUINQUATRUS, was a feftival kept at Rome in honour of Minerva, which began on the 18th of March, or as others will have it on the 19th, and lafted five days. On the firft day they offered facrifices and oblations without the effufion of blood; the fecond, third, and fourth, were fpent in fhows of gladiators; and on the fifth day they went in proceffion through the city. Scholars had a vacation during the folemnity, and prefented their mafters at this time with a gift or fee, called *Minerval*. Boys and girls ufed now to pray to the goddefs Minerva for wifdom and learning, of which fhe had the patronage. Plays were acted, and difputations held, at this feaft, on fubjects of polite literature. The quinquatria were fo called, becaufe they lafted for five days. There feems to be a ftrong refemblance betwixt this feftival and the panathenæa of the Greeks.

QUINQUENNALIS, in Roman antiquity, a magiftrate in the colonies and municipal cities of that empire, who had much the fame office as the ædile at Rome.

QUINQUEREMIS, in the naval architecture of the ancients, a name given to a galley which had five rows of oars. They divided their veffels in general into *monocrota* and *polycrota**. The former had only one tire of rowers: the latter had feveral tires of them, from two or three up to 20, 30, or even 40; for fuch a veffel we have an account of in the time of Philopater, which required no lefs than 4000 men to row it.

* See *Polycrota*.

Meibom has taken off from the imaginary improbability of there ever having been fuch a veffel, by reducing the enormous height fuppofed neceffary for fuch a number of rows of oars and men to work them, by finding a better way of placing the men than others had thought of. The quinqueremes of the ancients had 420 men in each; 300 of which were rowers, and the reft foldiers. The Roman fleet at Meffina confifted of 330 of thefe fhips; and the Carthaginian, at Lilybœum, of 350 of the fame fize. Each veffel was 150 feet long. Thus 130,000 men were contained in the one, and 150,000 in the other, with the apparatus and provifions neceffary for fuch expeditions as they were intended for. This gives fo grand an idea of the ancient naval armaments, that fome have queftioned the truth of the hiftory: but we find it related by Polybius, an hiftorian too authentic to be queftioned, and who expreffes his wonder at it while he relates it.

QUINQUEVIRI, in Roman antiquity, an order of five priefts, peculiarly appointed for the facrifices to the dead, or celebrating the rites of Erebus.

QUINQUINA. See CINCHONA.

QUINSY, or QUINZY. See MEDICINE, n° 177—183.

QUINTEN, a town of France, in Bretagne, with the title of a duchy, and a handfome caftle. It is feated in a valley near the river Guy, and near a large foreft of the fame name, eight miles fouth of St Brieux, and 200 weft of Paris. W. Long. 2. 40. N. Lat. 48. 26.

QUINTESSENCE, in chemiftry, a preparation confifting of the effential oil of fome vegetable fubftance, mixed and incorporated with fpirit of wine.

QUINTESSENCE, in alchemy, is a myfterious term, fignifying the fifth or laft and higheft effence of power in a natural body.

QUINTILE, in aftronomy, an afpect of the planets when they are 72 degrees diftant from one another, or a fifth part of the zodiac.

QUINTILIANUS (Marcus Fabius), a celebrated Latin orator, and the moft judicious critic of his time, was a native of Calagurris, or Calahorra, in Spain; and was the difciple of Domitius Afer, who died in the year 59. He taught rhetoric at Rome for 20 years with great applaufe: and not only laid down rules for fpeaking, but exhibited his eloquence at the bar. Some authors imagine, but with little foundation, that he arrived to the confulfhip; but it is more certain that he was preceptor to the grandfons of the emperor Domitian's fifter. There is ftill extant his excellent work, intitled, *Inftitutiones Oratoriæ*, which is a treatife of rhetoric in 12 books; where his precepts, judgment, and tafte, are juftly admired. Thefe inftitutions were found entire by Poggius, in an old tower of the abbey of St Gal, and not in a grocer's fhop in Germany as fome authors have imagined. There is alfo attributed to Quintilian a dialogue *De caufis corruptæ eloquentiæ*; but it is more commonly afcribed to Tacitus. The beft editions of Quintilian's works are thofe of Mr Obreight, publifhed at Strafburg in 2 vols 4to, in 1698, and of M. Capperonier, in folio. There is an Englifh tranflation by Mr Guthrie.

Quintilian had a son of the same name, on whom he bestows great praises. This son ought not to be confounded with Quintilian the father, or rather the grandfather, of him who is the subject of this article, and who wrote 145 declamations. Ugolin of Parma published the first 136 in the 15th century; the nine others were published in 1563 by Peter Ayrault, and afterwards by Peter Pithou in 1580. There have also been 19 other declamations printed under the name of Quintilian the Orator; but, in the opinion of Vossius, they were written neither by that orator nor his grandfather.

QUINTILIANS, a sect of ancient heretics, thus called from their prophetess Quintilia. In this sect the women were admitted to perform the sacerdotal and episcopal functions. They attributed extraordinary gifts to Eve for having first eaten of the tree of knowledge; told great things of Mary the sister of Moses, as having been a prophetess, &c. They added, that Philip the deacon had four daughters, who were all prophetesses, and were of their sect. In these assemblies it was usual to see the virgins entering in white robes, personating prophetesses.

QUINTIN MATSYS, also called the *Farrier of Antwerp*, famous for being transformed, by the force of love, from a blacksmith to a painter. He had followed the trade of a blacksmith and farrier near twenty years; when falling in love with a painter's daughter who was very handsome, and disliked nothing but his trade, he quitted it, and betook himself to painting, in which he made a very uncommon progress. He was a diligent and careful imitator of ordinary life, and succeeded better in representing the defects than the beauties of nature. Some historical performances of this master deserve commendation, particularly a Descent from the Cross, in the Cathedral at Antwerp: but his best known picture is that of the two Misers in the gallery at Windsor. He died in 1529.

QUINTINIE (John de la), a celebrated French gardener, born at Poictiers in 1626. He was brought up to the law; and acquitted himself so well at the bar as to acquire the esteem of the chief magistrate. M. Tamboneau, president of the chamber of accounts, engaged him to undertake the preceptorship of his only son, which Quintinie executed entirely to his satisfaction; applying his leisure hours to the study of writers on agriculture, ancient and modern, to which he had a strong inclination. He gained new lights by attending his pupil to Italy; for all the gardens about Rome being open to him, he failed not to add practice to his theory. On his return to Paris, M. Tamboneau gave up the management of his garden entirely to him; and Quintinie applied so closely to it, that he became famous all over France. Louis XIV. erected a new office purposely for him, that of director of the royal fruit and kitchen gardens; and these gardens, while he lived, were the admiration of the curious. He lived to a good old age, though we learn not the time of his death; his Directions for the Management of Fruit and Kitchen Gardens are esteemed all over Europe.

QUINTUS CALABER, a Greek poet, who wrote a large Supplement to Homer's Iliad, in 14 books, in which a relation is given of the Trojan war from the death of Hector to the destruction of Troy. It is conjectured, from his style and manner, that he lived in the fifth century. Nothing certain can be collected either concerning his person or country. His poem was first made known by Cardinal Bessarion, who discovered it in St Nicolas's church, near Otranto in Calabria; from whence the author was named *Quintus Calaber*. It was first published at Venice by Aldus, but it is not said in what year.

QUINTUS CURTIUS. See CURTIUS.

QUINZY, QUINSEY, or *Angina Pectoris*. See MEDICINE, n° 403.

QUIRE OF PAPER, the quantity of 24 or 25 sheets.

QUIRINALIA, in antiquity, a feast celebrated among the Romans in honour of Romulus.

QUIRITES, in Roman antiquity. In consequence of the agreement entered into by Romulus and Tatius king of the Sabines, Rome was to retain its name, taken from Romulus; and the people were to be called *Quirites*, from Cures, the principal town of the Sabines, a name used in all public addresses to the Roman people.——Dion. Hal. says, that each particular citizen was to be called *Romanus*; and the collective body of them *Quirites*; yet it appears by this ancient form of words used at funerals, *Ollus Quiris letho datus est*, that each private citizen was also called *Quiris*.

The origin of the word *Quirites*, which was at first peculiar to the Sabines, and became, in Romulus's time, the general name of the inhabitants of Rome, has been much sought for; and the most probable account antiquity gives us of it, is this: The word *Quiris*, according to Plutarch and some others, signified, in the Sabine language, both "a dart," and "a warlike deity armed with a dart." It is uncertain whether the god gave name to the dart, or the dart to the god. But be that as it will, this *Quiris*, or *Quirinus*, was either Mars or some other god of war; and the worship of *Quiris* continued in Rome all Romulus's reign: but after his death he was honoured with the name *Quirinus*, and took the place of the god *Quiris*.

QUIRK, in a general sense, denotes a subtilty or artful distinction.

QUIRK, in building, a piece of ground taken out of any regular ground-plot, or floor: thus, if the ground-plot were oblong or square, a piece taken out of a corner to make a court or yard, &c. is called a *quirk*.

QUISQUALIS, in botany: A genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the 31st order, *Veprecula*. The calyx is quinquefid and filiform; the petals five; the fruit is a quinqueangular plum. There is only one species, viz. INDICA.

QUITO, a town of South America, in Peru (see PERU, p. 213.), seated between two chains of high mountains called *Cordillera de los Andes*, on much higher ground than the rest of habitable Peru. It is 300 yards higher than the level of the sea according to the exactest observations. The town is 1600 yards long and 1200 broad, and is the seat of a bishop. It contains about 35,000 inhabitants, one third of whom are originally Spaniards. Among the inhabitants are some persons of high rank and distinction, descended either from the original conquerors, or persons who at different times came from Spain invested with some lucrative post. The number of these, however, is but small. The commonalty, besides Spaniards, consist of Mestizos, Indians, and Negroes; but the last are not proportionally

proportionally numerous. Merchandizes and commodities of all ſorts are extremely dear, partly on account of the difficulty of bringing them.

There are ſeveral religious communities at Quito, and two colleges or univerſities governed by Jeſuits and Dominicans.

The principal courts held at Quito are that of the royal audience, which conſiſts of the preſident, who is governor of the province with regard to law affairs; four auditors, who are at the ſame time civil and criminal judges; a royal fiſcal, who, beſides the cauſes brought before the audience, takes cognizance of every thing relating to the revenue; and an officer ſtyled the *protector of the Indians*, who ſolicits for them, and when they are injured pleads in their defence. The next is the treaſury, the chief officers of which are an accountant, a treaſurer, and a royal fiſcal. The tribunal of the Croiſade, which has a commiſſary, who is generally ſome dignitary of the church, and a treaſurer. There is alſo a treaſury for the effects of perſons deceaſed: an inſtitution eſtabliſhed all over the Indies, for receiving the goods of thoſe whoſe lawful heirs are in Spain, in order to ſecure them from thoſe accidents to which they might be liable in private hands. There is likewiſe a commiſſary of the inquiſition, with an alguazil-major and familiars, appointed by the inquiſition at Lima. The corporation conſiſts of a corregidor, two ordinary alcaldes, choſen annually, and regidores. The latter ſuperintend the election of the alcaldes, which is attended with no ſmall diſturbance, the people being divided into two parties, the Creoles and Europeans.

QUITTER-BONE, in farriery. See there, § xl. 4.

QUIT-RENT (*quietus redditus*, i. e. "quiet rent,") is a certain ſmall rent payable by the tenants of manors, in token of ſubjection, and by which the tenant goes quiet and free. In ancient records it is called *white rent*, becauſe paid in ſilver money, to diſtinguiſh it from rent-corn, &c.

QUOIN, or COIN, on board a ſhip, a wedge faſtened on the deck cloſe to the breach of the carriage of a gun, to keep it firm up to the ſhip's ſide. Cantic quoins are ſhort three-legged quoins put between caſks to keep them ſteady.

QUOINS, in architecture, denote the corners of brick or ſtone walls. The word is particularly uſed for the ſtones in the corners of brick buildings. When theſe ſtand out beyond the brick-work, their edges being chamfred off, they are called *ruſtic quoins*.

QUOTIDIAN, any thing which happens every day. Hence, when the paroxyſms of an ague recur every day, it is called a *quotidian ague*. See MEDICINE, n° 161—164.

QUOTIDIANA DECEPTIVA. See MEDICINE, n° 150.

QUOAD HOC, is a term uſed in the pleadings and arguments of lawyers; being as much as to ſay, As to this thing the law is ſo and ſo.

QUORUM, a word frequently mentioned in our ſtatutes, and in commiſſions both of juſtices of the peace and others. It is thus called from the words of the commiſſion, *quorum* A. B. *unum eſſe volumus*. For an example, where a commiſſion is directed to ſeven perſons, or to any three of them, whereof A. B. and C. D. are to be two; in this caſe, they are ſaid to be of the quorum, becauſe the reſt cannot proceed without them: ſo a juſtice of the peace and quorum is one without whom the reſt of the juſtices in ſome caſes cannot proceed.

QUOTIENT, in arithmetic, the number reſulting from the diviſion of a greater number by a ſmaller; and which ſhows how often the ſmaller is contained in the greater, or how often the diviſor is contained in the dividend. The word is formed from the Latin *quoties; q. d.* How often is ſuch a number contained in ſuch another?

In diviſion, as the diviſor is to the dividend, ſo is unity to the quotient.—Thus the quotient of 12 divided by 3 is 4; which is thus diſpoſed, 3) 12 (4 quotient. See ARITHMETIC.

R.

R, or *r*, a liquid conſonant, being the 17th letter of our alphabet. Its ſound is formed by a guttural extruſion of the breath vibrated through the mouth, with a ſort of quivering motion of the tongue drawn from the teeth, and canulated with the tip a little elevated towards the palate. In Greek words it is frequently aſpirated with an *h* after it, as in *rhapſody*, *rhetoric*, &c. otherwiſe it is always followed by a vowel at the beginning of words and ſyllables.

In the notes of the ancients, R. or RO. ſignifies *Roma;* R. C. *Romana civitas;* R. G. C. *rei gerendæ cauſa;* R. F. E. D. *recte factum et dictum;* R. G. F. *regis filius;* R. P. *res publica*, or *Romani principes;* and R. R. R. F. F. F. *res Romana ruet ferro, fame, flamma.*

Uſed as a numeral, R anciently ſtood for 80; and with a daſh over it, thus $\bar{R}$, for 80,000; but the Greek *r*, ρ́, with a ſmall mark over it, ſignified 100; with the ſame mark under it, it denoted 1000 × 100; thus ͵ρ ſignified 100,000. In the Hebrew numeration ר denoted 200: and with two horizontal points over it 1000 × 200; thus ר̈ = 200,000.

In the preſcriptions of phyſicians, R or ℞ ſtands for *recipe, i. e.* "take."

RAAB, a town of Lower Hungary, capital of Javerin, with a caſtle and a biſhop's ſee. It is a ſtrong frontier bulwark againſt the Turks, and has two bridges, one over a double ditch, and another that leads towards Alba Regalis. The ſurrounding country is plain, and there

there is nothing that seems to command it but a small hill at some distance, which is undermined and may be blown up. It was taken by Amurath III. with the loss of 20,000 men; but was surprised soon after by Count Palfi, who killed all the Turks that were found therein. It is seated at the confluence of the rivers Rab and Rabnitz, not far from the Danube, 32 miles west of Gran, and 55 south-east of Vienna. E. Long. 17. 25. N. Lat. 47. 48.

RABAC, a small port on the Arabian coast of the Red Sea, in N. Lat. 22° 35′ 40″ by Mr Bruce's account. The entry to the harbour is from the E. N. E. and is about a quarter of a mile broad. The port extends about two miles in length to the eastward. The mountains are about three leagues to the north, and the town about four miles north by east from the entrance to the harbour. The water is good, and all ships may be supplied here from the wells which are in the neighbourhood of the town. The country is bare and uncultivated; but from the appearance of it, and the freshness of the water, Mr Bruce supposes that it sometimes rains among the mountains here, which is the more probable as it is considerably within the tropic.

RABAT, a large and handsome sea-port town of Africa, in the kingdom of Fez and province of Tremesen. It has fine mosques and handsome palaces, and is seated at the mouth of the river Burrigrig, almost in the mid-way between Fez and Tangier. W. Long. 5. 28. N. Lat. 34. 40.

Rabat, together with Sallee, which is opposite to it, was formerly famous for fitting out piratical vessels; but the late emperor Sidi Mahomet subdued them both, and annexed them to the empire; since which time the harbour of Rabat has been so filled with the sand washed in by the sea as to render it unfit to carry on such piracies in future.

The town of Rabat, whose walls inclose a large space of ground, is defended on the sea-side by three forts tolerably well finished, which were erected some little time ago by an English renegado, and furnished with guns from Gibraltar. The houses in general are good, and many of the inhabitants are wealthy. The Jews, who are very numerous in this place, are generally in better circumstances than those of Larache or Tangier, and their women are extremely beautiful.

The castle, which is very extensive, contains a strong building, formerly used by the late emperor as his principal treasury, and a noble terrace, which commands an extensive prospect of the town of Sallee, the ocean, and all the neighbouring country. There are also the ruins of another castle, which is said to have been built by Jacob Almonzor, one of their former emperors, and of which at present very little remains but its walls, containing within them some very strong magazines for powder and naval stores. On the outside of these walls is a very high and square tower, handsomely built of cut stone, and called the tower of *Hassen*. From the workmanship of this tower, contrasted with the other buildings, a very accurate idea may be formed how greatly the Moors have degenerated from their former splendour and taste for architecture.

RABBETTING, in carpentry, the planning or cutting of channels or grooves in boards, &c.

In ship-carpentry, it signifies the letting in of the planks of the ship into the keel; which, in the rake and run of a ship, is hollowed away, that the planks may join the closer.

RABBI, or Rabbins, a title which the Pharisees and doctors of the law among the Jews assumed, and literally signifies *masters* or *excellents*.

There were several gradations before they arrived at the dignity of a rabbin; which was not conferred till they had acquired the profoundest knowledge of the law and the traditions. It does not, however, appear that there was any fixed age or previous examination necessary; but when a man had distinguished himself by his skill in the written and oral law, and passed through the subordinate degrees, he was saluted a rabbin by the public voice.

Among the modern Jews, for near 700 years past, the learned men retain no other title than that of *rabbi*, or *rabbins*; they have great respect paid them, have the first places or seats in their synagogues, determine all matters of controversy, and frequently pronounce upon civil affairs; they have even power to excommunicate the disobedient.

RABBINISTS, among the modern Jews, an appellation given to the doctrine of the rabbins concerning traditions, in opposition to the Caraites; who reject all traditions. See Caraite.

RABELAIS (Francis), a French writer famous for his facetiousness, was born at Chinon in Touraine about the year 1483. He was first a Franciscan friar; but quitting his religious habit studied physic at Montpelier, where he took his doctor's degree. It is said, that the chancellor du Pratt having abolished the privileges of the faculty of physic at Montpelier by a decree of the parliament, Rabelais had the address to make him revoke what he had done; and that those who were made doctors of that university wore Rabelais's robe, which is there held in great veneration. Some time after, he came to Rome, in quality of physician in ordinary to Cardinal John du Bellay archbishop of Paris. Rabelais is said to have used the freedom to jeer Pope Paul III. to his face. He had quitted his religious connections for the sake of leading a life more agreeable to his taste; but renewed them on a second journey to Rome, when he obtained, in 1536, a brief to qualify him for holding ecclesiastical benefices; and, by the interest of his friend Cardinal John du Bellay, he was received as a secular canon in the abbey of St Maur near Paris. His profound knowledge in physic rendered him doubly useful; he being as ready, and at least as well qualified, to prescribe for the body as for the soul: but as he was a man of wit and humour, many ridiculous things are laid to his charge, of which he was quite innocent. He published several things; but his chief performance is a strange incoherent romance, called the *History of Gargantua and Pantagruel*, being a satire upon priests, popes, fools, and knaves of all kinds. This work contains a wild, irregular profusion of wit, learning, obscenity, low conceits, and arrant nonsense; hence the shrewdness of his satire, in some places where he is to be understood, gains him credit for those where no meaning is discoverable. Some allusions may undoubtedly have been so temporary and local as to be now quite lost: but it is too much to conclude thus in favour of every unintelligible rhapsody; for we are not without English writers of great talents, whose sportive geniuses have betrayed them into puerilities, no less incoherent at

Rabbit. the times of writing than thofe of Rabelais appear above two centuries after. He died about 1553.

RABBIT, in zoology. See LEPUS.

The buck rabbits, like our boar cats, will kill the young ones if they can get at them; and the does in the warrens prevent this, by covering their ftocks, or nefts, with gravel or earth, which they clofe fo artificially up with the hinder part of their bodies, that it is hard to find them out. They never fuckle their young ones at any other time than early in the morning and late at night; and always, for eight or ten days, clofe up the hole at the mouth of the neft, in this careful manner when they go out. After this they begin to leave a fmall opening, which they increafe by degrees; till at length, when they are about three weeks old, the mouth of the hole is left wholly open that they may go out; for they are at that time grown big enough to take care of themfelves, and to feed on grafs.

People who keep rabbits tame for profit, breed them in hutches; but thefe muft be kept very neat and clean, elfe they will be always fubject to difeafes. Care muft be taken alfo to keep the bucks and does apart till the latter have juft kindled; then they are to be turned to the bucks again, and to remain with them till they fhun and run from them.

The general direction for the choofing of tame rabbits is, to pick the largeft and faireft; but the breeder fhould remember that the fkins of the filver-haired ones fell better than any other. The food of the tame rabbits may be colewort and cabbage-leaves, carrots, parfneps, apple-rinds, green corn, and vetches, in the time of the year; alfo vine-leaves, grafs, fruits, oats, and oatmeal, milk-thiftles, fow-thiftles, and the like: but with thefe moift foods they muft always have a proportionable quantity of the dry foods, as hay, bread, oats, bran, and the like, otherwife they will grow pot-bellied, and die. Bran and grains mixed together have been alfo found to be very good food. In winter they will eat hay, oats, and chaff, and thefe may be given them three times a-day; but when they eat green things, it muft be obferved that they are not to drink at all, for it would throw them into a dropfy. At all other times a very little drink ferves their turn, but that muft always be frefh. When any green herbs or grafs are cut for their food, care muft be taken that there be no hemlock among it; for though they will eat this greedily among other things when offered to them, yet it is fudden poifon to them.

Rabbits are fubject to two principal infirmities. Firft, the rot, which is caufed by giving them too large a quantity of greens, or from giving them frefh gathered with the dew or rain hanging in drops upon them. It is over-moifture that always caufes this difeafe. The greens therefore are always to be given dry; and a fufficient quantity of hay, or other dry food, intermixed with them, to take up the abundant moifture of their juices. On this account the very beft food that can be given them, is the fhorteft and fweeteft hay that can be got, of which one load will ferve 200 couples a year; and out of this ftock of 200, 200 may be eat in the family, 200 fold to the markets, and a fufficient number kept in cafe of accidents.

The other general difeafe of thefe creatures is a fort of madnefs: this may be known by their wallowing and tumbling about with their heels upwards, and hopping in an odd manner into their boxes. This diftemper is fuppofed to be owing to the ranknefs of their feeding; and the general cure is the keeping them low, and giving them the prickly herb called *tare-thiftle* to eat.

Rabbit.

The general computation of males and females is, that one buck-rabbit will ferve for nine does: fome allow 10 to one buck; but thofe who go beyond this always fuffer for it in their breed.

The wild rabbits are either to be taken by fmall cur-dogs, or by fpaniels bred up to the fport; and the places of hunting thofe who ftraggle from their burrows, is under clofe hedges or bufhes, or among corn-fields and frefh paftures. The owners ufe to courfe them with fmall greyhounds; and though they are feldom killed this way, yet they are driven back to their burrows, and are prevented from being a prey to others. The common method is by nets called *purfe-nets*, and ferrets. The ferret is fent into the hole to fetch them out; and the purfe-net being fpread over the hole, takes them as they come out. The ferrets mouths muft be muffled, and then the rabbit gets no harm. For the more certain taking of them, it may not be improper to pitch up a hay-net or two, at a fmall diftance from the burrows that are intended to be hunted: thus very few of the number that are attempted will efcape.

Some who have not ferrets fmoke the rabbits out of their holes with burning brimftone and orpiment. This certainly brings them out into the nets: but then it is a very troublefome and offenfive method; and is very detrimental to the place, as no rabbit will for a long time afterwards come near the burrows which have been fumed with thofe ftinking ingredients.

The tefticle of a rabbit is a very good object for examining the ftructure of this part of generation in animals. The whole fubftance of the tefticle in this animal is made up of veffels, which lie in round folds in the manner of the fmaller inteftines: but then both ends of each roll meet at their infertion, which feems to be made into the *ductus nervofus*; and every one of thefe little rolls is curioufly embroidered with other veffels, which, from their red colour, appear to be arteries and veins. The feveral little rolls lie in ranges, difpofed with an uniformity which is very agreeable to the eye. Every one of thefe rolls is not a fingle and entire tube, but each confifts of feveral tubes, befide the veins and arteries which embroider it. This is beft diftinguifhed by the cutting one of the rolls tranfverfely, and then examining the cut end with a glafs, which will appear to be made up of the cut and open ends of four, five, or more parallel tubes, which together form the roll, or fingle tube, as it appears to the eye, being all wrapped up in one common and very thin membrane. Thefe are fo tender that they cannot be explicated and viewed diftinct, as De Graaf tells us thofe of the tefticles of a rat and of fome other animals may. Thefe, however, as well as the others, are only made up of a congeries of veffels, and the liquors, which are their contents, without any intermediate fubftance, or any thing of that parenchyma which many authors have talked of. The tefticles of a bull have the greateft appearance of a flefhy texture of thofe of any known animal; yet even thefe afford no particle of parenchyma, or flefh, when examined by glaffes in any fort of preparation, whether boiled, raw, foaked in fpirits, or in whatever other ftate.

The

The tefticles of various animals are very varioufly compofed, but all in this general manner of veffels varioufly rolled and folded together: and even the human tefticles are of the fame fort; being compofed folely of rolls of veffels, without any intermediate fubftance, be it called by whatever name, but only confifting of veffels and their liquors.

RABIRIUS (C.) a Roman knight, who lent an immenfe fum of money to Ptolemy Auletes king of Egypt. The monarch afterwards not only refufed to repay him, but even confined him, and endangered his life. Rabirius efcaped from Egypt with difficulty; but at his return to Rome he was accufed by the fenate of having lent money to an African prince for unlawful purpofes. He was ably defended by Cicero, and acquitted with difficulty.—There was a Latin poet of the fame name in the age of Auguftus. He wrote a poem on the victory which the emperor had gained over Antony at Actium. Seneca has compared him to Virgil for elegance and majefty; but Quintilian is not fo favourable to his poetry.—And there was an architect in the reign of Domitian, called *Rabirius*. He built a celebrated palace for the emperor, of which the ruins are ftill feen at Rome.

RACCOON. See URSUS.

RACE, in general, fignifies running with others in order to obtain a prize, either on foot, or by riding on horfeback, in chariots, &c.

The race was one of the exercifes among the ancient Grecian games, which was performed in a courfe containing 125 paces; and thofe who contended in thefe foot-races were frequently clothed in armour. Chariot and horfe races alfo made a part of thefe ancient games.

Races were known in England in very early times. Fitz-Stephen, who wrote in the days of Henry II. mentions the great delight that the citizens of London took in the diverfion. But by his words, it appears not to have been defigned for the purpofes of gaming, but merely to have fprung from a generous emulation of fhowing a fuperior fkill in horfemanfhip.

Races appear to have been in vogue in the reign of Queen Elizabeth, and to have been carried to fuch excefs as to injure the fortunes of the nobility. The famous George earl of Cumberland is recorded to have wafted more of his eftate than any of his anceftors; and chiefly by his extreme love to horfe-races, tiltings, and other expenfive diverfions. It is probable that the parfimonious queen did not approve of it; for races are not among the diverfions exhibited at Kennelworth by her favourite Leicefter. In the following reign, were places allotted for the fport: Croydon in the fouth, and Garterly in Yorkfhire, were celebrated courfes. Camden alfo fays, that in 1607 there were races near York, and the prize was a little golden bell. See RACING.

RACE, in genealogy, a lineage or extraction continued from father to fon. See DESCENT.

RACINE (John), of the French academy, treafurer of France in the generality of Moulins, and fecretary to his majefty, was born at Ferre-Milon in 1639. He had a fine genius for the *Belles Lettres*, and became one of the firft poets of the age. He produced his *Thebaide* when but very young; and afterwards other pieces, which met with great fuccefs, though they appeared when Corneille was in his higheft reputation. In his career, however, he did not fail to meet with all that oppofition which envy and cabal are ever ready to fet up againft a fuperior genius. It was partly owing to a chagrin from this circumftance that he took a refolution to quit the theatre for ever; although his genius was ftill in full vigour, being not more than 38 years of age. But he had alfo imbibed in his infancy a deep fenfe of religion; and this, though it had been fmothered for a while by his connections with the theatre, and particularly with the famous actrefs Champmelle, whom he greatly loved, and by whom he had a fon, now at length broke out, and bore down all before it. In the firft place, he refolved not only to write no more plays, but to do a rigorous penance for thofe he had written; and he actually formed a defign of becoming a Carthufian friar. His religious director, however, a good deal wifer than he, advifed him to think more moderately, and to take meafures more fuitable to his character. He put him upon marrying, and fettling in the world: with which propofal this humble and tractable penitent complied; and immediately took to wife the daughter of a treafurer of France for Amiens, by whom he had feven children.

He had been admitted a member of the French academy in 1673, in the room of La Mothe le Vayer deceafed; but fpoiled the fpeech he had made upon that occafion by pronouncing it with too much timidity. In 1677, he was nominated with Boileau, with whom he was ever in ftrict friendfhip, to write the hiftory of Louis XIV.; and the public expected great things from two writers of their diftinction, but were difappointed. Boileau and Racine, after having for fome time laboured at this work, perceived that it was entirely oppofite to their genius.

He fpent the latter years of his life in compofing a hiftory of the houfe of Port-Royal, the place of his education; which, however, though finely drawn up, as many have afferted, has not been publifhed. Too great fenfibility, fay his friends, but more properly an impotence of fpirit, fhortened the days of this poet.—Though he had converfed much with the court, he had not learned the wifdom, which is ufually learned there, of difguifing his real fentiments. Having drawn up a well-reafoned and well-written memorial upon the miferies of the people, and the means of relieving them, he one day lent it to Madam de Maintenon to read; when the king coming in, and demanding what and whofe it was, commended the zeal of Racine, but difapproved of his meddling with things that did not concern him: and faid with an angry tone, "Becaufe he knows how to make good verfes, does he think he knows every thing? And would he be a minifter of ftate, becaufe he is a great poet?" Thefe words hurt Racine greatly: he conceived dreadful ideas of the king's difpleafure; and his chagrin and fears brought on a fever, of which he died the 22d of April 1699.

The king, who was fenfible of his great merit, and always loved him, fent often to him in his illnefs; and finding after his death that he had more glory than riches, fettled a handfome penfion upon his family.—There is nothing in the French language written with more wit and elegance than his pieces in profe. Befides his plays, feveral of his letters have been publifhed; he alfo wrote fpiritual fongs, epigrams, &c. Racine's works

Racing.

works were printed at Amſterdam in 1722, in 2 vols 12mo, and the next year a pompous edition was printed in 2 vols quarto.

RACING, the riding heats for a plate, or other premium. See PLATE. The amuſement of horſe-racing, which is now ſo common, was not unknown among the great nations of antiquity, nor wholly unpractiſed by our anceſtors in Britain, as we have already mentioned in the article RACE. In 1599, private matches between gentlemen, who were their own jockies and riders, were very common; and, in the reign of James I. public races were eſtabliſhed at various places, when the diſcipline, and mode of preparing the horſes for running, &c. were much the ſame as they are now. The moſt celebrated races of that time were called bell-courſes, the prize of the conqueror being a bell: hence, perhaps, the phraſe of *bearing the bell*, when applied to excellence, is derived. In the latter end of Charles I.'s reign, races were performed in Hyde-Park. Newmarket was alſo a place for the ſame purpoſe, though it was firſt uſed for hunting. Racing was revived ſoon after the Reſtoration, and much encouraged by Charles II. who appointed races for his own amuſement at Datchet Mead, when he reſided at Windſor. Newmarket, however, now became the principal place. The king attended in perſon, eſtabliſhed a houſe for his own accommodation, and kept and entered horſes in his own name. Inſtead of bells, he gave a ſilver bowl or cup value 100 guineas; on which prize the exploits and pedigree of the ſucceſsful horſe were generally engraved. Inſtead of the cup or bowl, the royal gift is now a hundred guineas. William III. not only added to the plates, but even founded an academy for riding; and Queen Anne continued the bounty of her anceſtors, adding ſeveral plates herſelf. George I. towards the end of his reign, diſcontinued the plates, and gave in their room a hundred guineas. An act was paſſed in the 13th year of the reign of George II. for ſuppreſſing races by poneys and other ſmall and weak horſes, &c. by which all matches for any prize under the value of 50 l. are prohibited, under a penalty of 200 l. to be paid by the owner of each horſe running, and 100 l. by ſuch as advertiſe the plate; and by which each horſe entered to run, if five years old, is obliged to carry ten ſtones; if ſix, eleven; and if ſeven, twelve. It is alſo ordained, that no perſon ſhall run any horſe at a courſe, unleſs it be his own, nor enter more than one horſe for the ſame plate, upon pain of forfeiting the horſes; and alſo every horſe-race muſt be begun and ended in the ſame day. Horſes may run for the value of 50 l. with any weight, and at any place. 13 Geo. II. cap. 19. 18 George II. cap. 34. Pennant's Britiſh Zoology, vol. i. p. 6, &c. Berenger's Hiſtory and Art of Horſemanſhip, vol. i. p. 185, &c. At Newmarket there are two courſes, the long and the round: the firſt is exactly four miles and about 380 yards, *i. e.* 7420 yards. The ſecond is 6640 yards. Childers, the ſwifteſt horſe ever known, has run the firſt courſe in ſeven minutes and a half, and the ſecond in ſix minutes forty ſeconds; which is at the rate of more than forty-nine feet in a ſecond. But all other horſes take up at leaſt ſeven minutes and fifty ſeconds in completing the firſt and longeſt courſe, and ſeven minutes only in the ſhorteſt, which is at the rate of more than forty-ſeven feet in a ſecond. And it is commonly ſuppoſed that theſe courſers cover, at every bound, a ſpace of ground in length about twenty-four Engliſh feet. Race-horſes have been for ſome time an object of taxation.

Rachitis, Rack.

RACHITIS, the RICKETS. See MEDICINE, n° 347.

RACK (Edmund), a perſon well known in the literary world by his attachment to, and promotion of, agricultural knowledge: he was a native of Norfolk, a Quaker. His education was common, and he was apprenticed originally to a ſhopkeeper: his ſociety was ſelect in this ſituation, and by improving himſelf in learning, his converſation was enjoyed by a reſpectable acquaintance. He wrote many eſſays, poems, and letters, and ſome few controverſial tracts. At length he ſettled, about his 40th year, at Bath in 1775, and was ſoon introduced to the moſt eminent literati of that place, among whom Dr Wilſon and Mrs Macaulay highly eſteemed him for his integrity and abilities. In 1777 he publiſhed *Mentor's Letters*, a moral work, which has run through many editions. But this year he gained great celebrity by his plan of an agricultural ſociety, which was ſoon adopted by four counties. He ſtill further advanced his fame by his papers in the Farmer's Magazine, and his communications in the Bath Society's papers; a work remarkable for its ingenuity and ſpirit. His laſt engagement was in the Hiſtory of Somerſetſhire, where the topographical parochial ſurveys were his. This work, in 3 vols 4to, was publiſhed in 1791, by his colleague the Reverend Mr Collinſon.—Mr Rack died of an aſthma in February 1787, aged 52.

RACK, an engine of torture, furniſhed with pulleys, cords, &c. for extorting confeſſion from criminals.—The trial by rack is utterly unknown to the law of England; though once, when the dukes of Exeter and Suffolk, and other miniſters of Henry VI. had laid a deſign to introduce the civil law into this kingdom as the rule of government; for a beginning thereof they erected a rack for torture, which was called in deriſion the duke of Exeter's daughter, and ſtill remains in the Tower of London, where it was occaſionally uſed as an engine of ſtate, not of law, more than once in the reign of Queen Elizabeth. But when, upon the aſſaſſination of Villiers duke of Buckingham, by Felton, it was propoſed in the privy council to put the aſſaſſin to the rack, in order to diſcover his acccomplices; the judges, being conſulted, declared unanimouſly, to their own honour and the honour of the Engliſh law, that no ſuch proceeding was allowable by the laws of England. It ſeems aſtoniſhing that this uſage of adminiſtering the torture ſhould be ſaid to ariſe from a tenderneſs to the lives of men; and yet this is the reaſon given for its introduction in the civil law, and its ſubſequent adoption by the French and other foreign nations, viz. becauſe the laws cannot endure that any man ſhould die upon the evidence of a falſe, or even a ſingle witneſs, and therefore contrived this method that innocence ſhould manifeſt itſelf by a ſtout denial, or guilt by a plain confeſſion: thus rating a man's virtue by the hardineſs of his conſtitution, and his guilt by the ſenſibility of his nerves. The Marquis Beccaria, in an exquiſite piece of raillery, has propoſed this problem, with a gravity and preciſion that are truly mathematical: "The force of the muſcles and the ſenſibility of the nerves of an innocent perſon being given; it is required to find the degree of pain neceſſary to make him confeſs

confess himself guilty of a given crime." See *Act of Faith*, Inquisition, and Torture.

Rack, a spirituous liquor made by the Tartars of Tongusa. This kind of rack is made of mare's milk, which is left to be sour, and afterwards distilled twice or thrice between two earthen pots closely stopped; whence the liquor runs through a small wooden pipe. This liquor is more intoxicating than brandy distilled from wine.

Rack, or *Arack*. See Arack.

To Rack Wines, &c. To draw them off from their lees, after having stood long enough to ebb and settle. Hence rack-vintage is frequently used for the second voyage our wine-merchants use to make into France for racked wines.

RACKOON, in zoology, a species of Ursus.

RACONI, a populous town of Italy, in Piedmont, seated in a pleasant plain, on the road from Savillan to Turin, on the rivers Grana and Macra. It belongs to the prince of Carignan, who has a handsome castle here. It is six miles from Savillan, and six from Carignan. E. Long. 7. 46. N. Lat. 44. 39.

RADCLIFFE (Dr John), an English physician of great eminence in his time, born at Wakefield in Yorkshire in 1650. He was educated at Oxford, and enrolled himself upon the physical line; but it was remarkable that he recommended himself more by his ready wit and vivacity, than by any extraordinary acquisitions in learning. He began to practise at Oxford in 1675; but never paid any regard to established rules, which he censured whenever he thought fit, with great freedom and acrimony; and as this drew all the old practitioners upon him, he lived in a continual state of hostility with them. Nevertheless, his reputation increased with his experience; so that, before he had been two years in business, his practice was very extensive among persons of high rank. In 1684 he removed to London, and settled in Bow-street, Covent Garden, where in less than a year he got into prime business.—In 1687 the princess Anne of Denmark made him her physician: yet when her husband and she joined the prince of Orange, Radcliffe, either not choosing to declare himself, or unwilling to favour the measures then in agitation, excused himself from attending them, on the plea of the multitude of his patients. Nevertheless, he was often sent for to King William and other great personages, though he did not incline to be a courtier. He incurred some censure for his treatment of Q. Mary, who died of the small-pox; and soon after lost his place about the princess Anne, by his attachment to his bottle. He also totally lost the favour of K. William by his uncourtly freedom; for, in 1699, when the king showed him his swollen ankles, while the rest of his body was emaciated, and asked him what he thought of them? "Why truly I would not have your majesty's two legs for your three kingdoms," replied Radcliffe. He continued increasing in business and insolence as long as he lived, continually at war with his brethren the physicians; who considered him in no other light than that of an active ingenious empiric, whom constant practice had at length brought to some degree of skill in his profession. He died in 1714; and if he never attempted to write any thing himself, has perpetuated his memory by founding a fine library at Oxford, to preserve the writings of other men.

RADIALIS, the name of two muscles in the arm. See Anatomy, *Table of the Muscles*.

RADIANT, in optics, is any point of a visible object from whence rays proceed.

RADIATED flowers, in botany, are such as have several semiflosculés set round a disk, in form of a radiant star; those which have no such rays are called *discous flowers*.

RADIATION, the act of a body emitting or diffusing rays of light all round as from a centre.

RADICAL, in general, something that serves as a basis or foundation. Hence physicians talk much of a radical moisture. In grammar, we give the appellation *radical* to primitives, in contradistinction to compounds and derivatives. Algebraists also speak of the radical sign of quantities, which is the character expressing their roots.

RADICLE, that part of the seeds of all plants which upon vegetating becomes their root, and is discoverable by the microscope. See Plant.

RADISH, in botany. See Raphanus.

RADIUS, in geometry, the semidiameter of a circle, or a right line drawn from the centre to the circumference.

In trigonometry, the radius is termed the whole sine, or sine of 90°. See Sine.

Radius, in anatomy, the exterior bone of the arm, descending along with the ulna from the elbow to the wrist.

RADNOR, the county-town of Radnorshire, in South Wales. It is a poor little place, distant from London about 150 miles. It is situated near the spring-head of the river Somergil, in a fruitful valley at the bottom of a hill, where there are sheep grazing in abundance. It is a very ancient borough-town, whose jurisdiction extends near 12 miles round about: the government of it is vested in a bailiff and 25 burgesses. Though it is the county-town, the assizes are held at Presteign: it has one privilege, however, that is very extraordinary, besides that of sending one member to parliament; and that is, it keeps a court of pleas for all actions, without being limited to any particular sum. It was formerly fenced with a wall and a strong castle; but both were in a great measure demolished by Owen Glendower, when he assumed the title of Prince of Wales, upon the deposition of King Richard II. W. Long. 2. 45. N. Lat. 52. 10.

RADNORSHIRE, a county of South Wales, is bounded on the north by Montgomeryshire; on the east by Shropshire and Herefordshire; on the south and south-west by Brecknockshire; and on the west by Cardiganshire; extending 30 miles in length and 25 in breadth. This county is divided into six hundreds, in which are contained three market-towns, 52 parishes, about 3160 houses, and 18,960 inhabitants. It is seated in the diocese of Hereford, and sends two members to parliament, one for the county and one for the town of Radnor. The air of this county is in winter cold and piercing. The soil in general is but indifferent; yet some places produce corn, particularly the eastern and southern parts; but in the northern and western, which are mountainous, the land is chiefly stocked with horned cattle, sheep, and goats.

RADIX. See Root.

RAFT, a sort of float, formed by an assemblage of

various planks or pieces of timber, faſtened together ſide by ſide, ſo as to be conveyed more commodiouſly to any ſhort diſtance in a harbour or road than if they were ſeparate. The timber and plank with which merchant-ſhips are laden, in the different parts of the Baltic Sea, are attached together in this manner, in order to float them off to the ſhipping,

RAFTERS, in building, are pieces of timber which, ſtanding by pairs on the reaſon or railing piece, meet in an angle at the top, and form the roof of a building. See ARCHITECTURE.

ROWLEY RAGG, a genus of ſtones, belonging to the ſiliceous claſs. It is of a duſky or dark grey colour, with many ſmall ſhining cryſtals, having a granular texture, and acquiring an ochry cruſt by expoſure to the air. The ſpecific gravity is 2748. It becomes magnetic by being heated in an open fire. In a ſtrong fire it melts without addition, but with more difficulty than baſaltes. It was analyſed by Dr Withering, who found that 100 parts of it contain 47.5 of ſiliceous earth, 32.5 of argil, and 20 of iron.

RAGMAN's ROLL, Rectius Ragimund's roll, ſo called from one Ragimund a legate in Scotland, who calling before him all the beneficed clergymen in that kingdom, cauſed them on oath to give in *the true value* of their benefices; according to which they were afterwards taxed by the court of Rome; and this roll, among other records, being taken from the Scots by Edward I. was redelivered to them in the beginning of the reign of Edward III.

RAGOUT, or RAGOO, a ſauce, or ſeaſoning, intended to rouſe the appetite when loſt or languiſhing.

This term is alſo uſed for any high-ſeaſoned diſh prepared of fleſh, fiſh, greens, or the like; by ſtewing them with bacon, ſalt, pepper, cloves, and the like ingredients. We have ragouts of celery, of endive, aſparagus, cock's combs, giblets, craw-fiſh, &c.

The ancients had a ragout called *garum*, made of the putrified guts of a certain fiſh kept till it diſſolved into a mere ſanies, which was thought ſuch a dainty, that, according to Pliny, its price equalled that of the richeſt perfumes.

RAGSTONE, a genus of ſtones belonging to the claſs of ſiliceous earths. It is of a grey colour; the texture obſcurely laminar, or rather fibrous; but the laminæ or fibres conſiſt of a congeries of grains of a quartzy appearance, coarſe and rough. The ſpecific gravity is 2729; it effervefces with acids, and ſtrikes fire with ſteel. Mr Kirwan found it to contain a portion of mild calareous earth, and a ſmall proportion of iron. It is uſed as a whetſtone for coarſe cutting tools. It is found about Newcaſtle, and many other parts of England, where there are large rocks of it in the hills.

RAGULED, or RAGGED, in heraldry, jagged or knotted. This term is applied to a croſs formed of the trunks of two trees without their branches, of which they ſhow only the ſtumps. *Raguled* differs from *indented*, in that the latter is regular, the former not.

RAGUSA, an ancient town of Sicily, in the Val-di-Noto, near the river Maulo, 12 miles north of Modica. E. Long. 14. 59. N. Lat. 37. 0.

RAGUSA, a city of Dalmatia, and capital of Raguſen. It is about two miles in circumference, is pretty well built, and ſtrong by ſituation, having an inacceſſible mountain on the land-ſide, and on the ſide of the ſea a ſtrong fort. It has an archbiſhop's ſee and a republic, and has a doge like that of Venice, but he continues a month only in his office. It carries on a conſiderable trade with the Turks, and is 60 miles north-weſt of Scutari, and 110 north of Brindiſi. E. Long. 18. 10. N. Lat. 42. 50.

RAGUSEN, a territory of Europe in Dalmatia, lying along the coaſt of the gulph of Venice, about 55 miles in length, and 20 in breadth. It is a republic under the protection of the Turks and Venetians. Raguſa is the capital town.

RAJA, the title of the Indian black princes, the remains of thoſe who ruled there before the Moguls. Some of the rajas are ſaid to preſerve their independency, eſpecially in the mountainous parts; but moſt of them pay an annual tribute to the Mogul. The Indians call them *rai;* the Perſians, *raian*, in the plural; and our travellers *rajas*, or *ragias*.

RAJA, the *Ray-Fiſh*, in ichthyology; a genus belonging to the order of Chondropterygia. There are five ſpiracula below towards the peak; the body compreſſed; and the mouth is ſituated under the head. The moſt remarkable ſpecies are,

1. The batis, or ſkate: this ſpecies is the thinneſt in proportion to its bulk of any of the genus, and alſo the largeſt, ſome weighing near 200 pounds. The noſe, though not long, is ſharp pointed; above the eyes is a ſet of ſhort ſpines: the upper part is of a pale brown, ſometimes ſtreaked with black: the lower part is white, marked with great numbers of minute black ſpots. The jaws are covered with ſmall granulated but ſharp-pointed teeth. The tail is of a moderate length: near the end are two fins: along the top of it is one row of ſpines, and on the edges are irregularly diſperſed a few others, which makes us imagine with Mr Ray, that in this reſpect theſe fiſh vary, ſome having one, others more orders of ſpines on the tail. It is remarked, that in the males of this ſpecies the fins are full of ſpines. Skates generate in March and April; at which time they ſwim near the ſurface of the water, ſeveral of the males purſuing one female. They adhere ſo faſt together in coition, that the fiſhermen frequently draw up both together, though only one has taken the bait. The females begin to caſt their *purſes*, as the fiſhermen call them (the bags in which the young are included) in May, and continue doing it till September. In October they are exceedingly poor and thin; but in November they begin to improve, and grow gradually better till May, when they are in the higheſt perfection. The males go ſooner out of ſeaſon than the females.

2. The oxyrinchus, or ſharp-noſed ray, in length near ſeven feet, and breadth five feet two inches; when juſt brought on ſhore, it makes a remarkable ſnorting noiſe. The noſe is very long, narrow, and ſharp-pointed, not unlike the end of a ſpontoon. The body is ſmooth, and very thin in proportion to the ſize; the upper part aſh-coloured, ſpotted with numerous white ſpots, and a few black ones. The tail is thick; towards the end are two ſmall fins; on each ſide is a row of ſmall ſpines, with another row in the middle, which runs ſome way up the back. The lower part of the fiſh is quite white. The mouth is very large, and furniſhed with numbers of ſmall ſharp teeth bending inwards. This fiſh has been ſuppoſed to be the *bos* of the anci-

Raja.

ents; which was certainly some enormous species of ray, though we cannot pretend to determine the particular kind. Oppian styles it, *the broadest among fishes*: he adds an account of its fondness of human flesh, and the method it takes of destroying men, by over-laying and keeping them down by its vast weight till they are drowned. Phile (*De propriet. anim.* p. 85.) gives much the same relation. We are inclined to give them credit, since a modern writer, of undoubted authority *, gives the very same account of a fish found in the South Seas, the terror of those employed in the pearl-fishery. It is a species of ray, called there *manta*, or the *quilt*, from its surrounding and wrapping up the unhappy divers till they are suffocated; therefore the negroes never go down without a sharp knife to defend themselves against the assaults of this terrible enemy.

* Ulloa's Voyage, i. 132.

3. The aspera, or rough ray, is found in Loch-Broom in Scotland. The length from the nose to the tip of the tail is two feet nine. The tail is almost of the same length with the body. The nose is very short. Before each eye is a large hooked spine; and behind each another, beset with lesser. The upper part of the body is of a cinereous brown mixed with white, and spotted with black; and entirely covered with small spines. On the tail are three rows of great spines: all the rest of the tail is irregularly beset with lesser. The fins and under side of the body are equally rough with the upper. The teeth are flat and rhomboidal.

4. The fullonica, or fuller, derives its Latin name from the instrument fullers make use of in smoothing cloth, the back being rough and spiney. The nose is short and sharp. At the corner of each eye are a few spines. The membrane of nictitation is fringed. Teeth small and sharp. On the upper part of the pectoral fins are three rows of spines pointing towards the back, crooked like those on a fuller's instrument. On the tail are three rows of strong spines: the middle row reaches up part of the back. The tail is slender, and rather longer than the body. The colour of the upper part of the body is cinereous, marked usually with numerous black spots: the lower part is white. This, as well as most other species of rays, vary a little in colour, according to age. This grows to a size equal to the skate. It is common at Scarborough, where it is called the *white hans*, or *gullet*.

5. The shagreen ray increases to the size of the skate; is fond of launces or sand-eels, which it takes generally as a bait. The form is narrower than that of the common kinds; the nose long and very sharp; pupil of the eye sapphirine; on the nose are two short rows of spines; on the corner of the eyes another of a semicircular form; on the tail are two rows, continued a little up the back, small, slender, and very sharp: along the sides of the tail is a row of minute spines, intermixed with innumerable little spiculæ. The upper part of the body is of a cinereous brown, covered closely with shagreen-like tubercles, resembling the skin of the dog-fish: the under side of the body is white; from the nose to the beginning of the pectoral fins is a tuberculated space. The teeth slender, and sharp as needles.

6. The torpedo, cramp-fish, or electric ray, is frequently taken in Torbay; has been once caught off Pembroke, and sometimes near Waterford in Ireland. It is generally taken, like other flat fish, with the trawl; but there is an instance of its taking the bait. It commonly lies in water of about 40 fathoms depth; and in company with the congenerous rays. The torpedo brings forth its young at the autumnal equinox, as affirmed by Aristotle. A gentleman of La Rochelle, on dissecting certain females of this species, the 10th of September, found in the matrices several of the fœtuses quite formed, and nine eggs in no state of forwardness: superfœtation seems therefore to be a property of this fish. The food of the torpedo is fish; a surmullet and a plaise have been found in the stomach of two of them. The surmullet is a fish of that swiftness, that it was impossible for the torpedo to take it by pursuit. It is probable, therefore, that by their electric stroke they stupify their prey; yet the crab and sea-leech will venture to annoy them. They will live 24 hours out of the sea; and but very little longer if placed in fresh water. They inhabit sandy places; and will bury themselves superficially in it, by flinging the sand over, by a quick flapping of all the extremities. It is in this situation that the torpedo gives his most forcible shock, which throws down the astonished passenger who inadvertently treads upon him. In our seas it grows to a great size, and above 80 pounds weight. The tail is thick and round; the caudal fin broad and abrupt. The head and body, which are indistinct, are nearly round; attenuating to extreme thinness on the edges; below the body, the ventral fins form on each side a quarter of a circle. The two dorsal fins are placed on a trunk of the tail. The eyes are small, placed near each other: behind each is a round spiracle, with six small cutaneous rags on their inner circumference. Mouth small; teeth minute, spicular. Five openings to the gills, as in others of this genus. The skin everywhere smooth; cinereous brown above, white beneath. See further the article ELECTRICITY, n° 258—261.

7. The clavata, or thornback, is easily distinguished from the others by the rows of strong sharp spines disposed along the back and tail. In a large one seen by Mr Pennant, were three rows on the back, and five on the tail, all inclining towards its end. On the nose, and on the inner side of the forehead, near the eyes, were a few spines, and others were scattered without any order on the upper part of the pectoral fins. The mouth was small, and filled with granulated teeth: The upper part of the body was of a pale ash colour, marked with short streaks of black, and the skin rough, with small tubercles like shagreen. The belly white, crossed with a strong semilunar cartilage beneath the skin: in general, the lower part was smooth, having only a few spines on each side. The young fish have very few spines on them; and their backs are often spotted with white, and each spot is encircled with black. This species frequents our sandy shores; are very voracious, and feed on all sorts of flat fish; are particularly fond of herrings and sand-eels; and sometimes eat crustaceous animals, such as crabs. These sometimes weigh 14 or 15 pounds, but with us seldom exceed that weight. They begin to generate in June, and bring forth their young in July and August, which (as well as those of the skate) before they are old enough to breed, are called *maids*. The thornback begins to be in season in November, and continues so later than the skate, but the young of both are good at all times of the year.

8. The pastinaca, or sting ray, does not grow to the bulk of the others: The body is quite smooth, of shape almost round, and is of a much greater thickness and more

more elevated form in the middle than any other rays, but grows thin towards the edges. The nofe is very fharp pointed, but fhort; the mouth fmall, and filled with granulated teeth. The irides are of a gold colour: behind each eye the orifice is very large. The tail is very thick at the beginning: the fpine is placed about a third the length of the former from the body; is about five inches long, flat on the top and bottom, very hard, fharp pointed, and the two fides thin, and clofely and fharply bearded the whole way. The tail extends four inches beyond the end of this fpine, and grows very flender at the extremity. Thefe fifh are obferved to fhed their fpine, and renew them annually; fometimes the new fpine appears before the old one drops off; and the Cornifh call this fpecies *cardinal trilost*, or *three-tailed*, when fo circumftanced. The colour of the upper part of the body is a dirty yellow, the middle part of an obfcure blue: the lower fide white, the tail and fpine dufky. The weapon with which nature has armed this fifh, hath fupplied the ancients with many tremendous fables relating to it. Pliny, Ælian, and Oppian, have given it a venom that affects even the inanimate creation: trees that are ftruck by it inftantly lofe their verdure and perifh, and rocks themfelves are incapable of refifting the potent poifon. The enchantrefs Circe armed her fon with a fpear headed with the fpine of the trygon, as the moft irrefiftible weapon fhe could furnifh him with; and with which he afterwards committed parricide, unintentionally, on his father Ulyffes. That fpears and darts might, in very early times, have been headed with this bone inftead of iron, we have no kind of doubt; that of another fpecies of this fifh being ftill ufed to point the arrows of fome of the South American Indians, and is, from its hardnefs, fharpnefs, and beards, a moft dreadful weapon. But in refpect to its venomous qualities, there is not the leaft credit to be given to the opinion, though it was believed (as far as it affected the animal world) by Rondeletius, Aldrovand, and others, and even to this day by the fifhermen in feveral parts of the kingdom. It is in fact the weapon of offence belonging to the fifh, capable of giving a very bad wound, and which is attended with dangerous fymptoms when it falls on a tendinous part or on a perfon in a bad habit of body. As to any fifh having a fpine charged with actual poifon, it feems very dubious, though the report is fanctified by the name of Linnæus. He inftances the *pastinaca*, the *torpedo*, and the *tetrodon lineatus*. The firft is incapable of conveying a greater injury than what refults from the mere wound; the fecond, from its electric effluvia; and the third, by imparting a pungent pain like the fting of nettles, occafioned by the minute fpines on its abdomen.

RAIANIA, in botany: A genus of the hexandria order, belonging to the dioecia clafs of plants; and in the natural method ranking under the 11th order, *Sarmentaceæ*. The male calyx is fexpartite; there is no corolla. The female calyx as in the male, without any corolla; there are three ftyles; the fruit is roundifh with an oblique wing, inferior. There are three fpecies, the haftata, cordata, and quinquefolia.

RAIETEA, one of the South Sea iflands, named alfo ULIETEA.

RAIL, in ornithology. See RALLUS.

RAILLERY, according to Dr Johnfon, means flight fatire, or fatirical merriment; and a beautiful writer of the laft century compares it to a light which dazzles, and which does not burn. It is fometimes innocent and pleafant, and it fhould always be fo, but it is moft frequently offenfive. Raillery is of various kinds; there is a ferious, fevere, and good-humoured raillery; and there is a kind which perplexes, a kind which offends, and a kind which pleafes.

To rally well, it is abfolutely neceffary that kindnefs run through all you fay; and you muft ever preferve the character of a friend to fupport your pretenfions to be free with a man. Allufions to paft follies, hints to revive what a man has a mind to forget for ever, fhould never be introduced as the fubjects of raillery. This is not to thruft with the fkill of fencers, but to cut with the barbarity of butchers. But it is below the character of men of humanity and good-breeding to be capable of mirth, while there is any in the company in pain and diforder.

RAIN, the defcent of water from the atmofphere in the form of drops of a confiderable fize. By this circumftance it is diftinguifhed from dew and fog: in the former of which the drops are fo fmall that they are quite invifible; and in the latter, though their fize is larger, they feem to have very little more fpecific gravity than the atmofphere itfelf, and may therefore be reckoned hollow fpherules rather than drops.

It is univerfally agreed, that rain is produced by the water previoufly abforbed by the heat of the fun, or otherwife, from the terraqueous globe, into the atmofphere; but very great difficulties occur when we begin to explain why the water, once fo clofely united with the atmofphere, begins to feparate from it. We cannot afcribe this feparation to cold, fince rain often takes place in very warm weather; and though we fhould fuppofe the condenfation owing to the fuperior cold of the higher regions, yet there is a remarkable fact which will not allow us to have recourfe to this fuppofition. It is certain that the drops of rain increafe in fize confiderably as they defcend. On the top of a hill, for inftance, they will be fmall and inconfiderable, forming only a drizzling fhower; but at the bottom of the fame hill the drops will be exceffively large, defcending in an impetuous rain; which fhows that the atmofphere is difpofed to condenfe the vapours, and actually does fo, as well where it is warm as where it is cold.

For fome time the fuppofitions concerning the caufe of rain were exceedingly infufficient and unfatisfactory. It was imagined, that when various congeries of clouds were driven together by the agitation of the winds, they mixed, and run into one body, by which means they were condenfed into water. The coldnefs of the upper parts of the air alfo was thought to be a great means of collecting and condenfing the clouds into water; which, being heavier than the air, muft neceffarily fall down through it in the form of rain. The reafon why it falls in drops, and not in large quantities, was faid to be the refiftance of the air; whereby being broken, and divided into fmaller and fmaller parts, it at laft arrives to us in fmall drops. But this hypothefis is entirely contrary to almoft all the phenomena: for the weather, when coldeft, that is, in the time of fevere froft, is generally the moft ferene; the moft violent rains alfo happen where there is little or no cold to condenfe the clouds; and the drops of rain, inftead of being divided into fmaller and fmaller ones as they approach the earth, are plainly increafed in fize as they defcend.

Dr

Rain.

Dr Derham accounted for the precipitation of the drops of rain from the veficulæ being full of air, and meeting with an air colder than they contained, the air they contained was of confequence contracted into a fmaller fpace; and confequently the watery fhell rendered thicker, and thus fpecifically heavier, than the common atmofphere. But it has been fhown, that the veficulæ, if fuch they are, of vapour, are not filled with air, but with fire, or heat; and confequently, till they part with this latent heat, the vapour cannot be condenfed §. Now, cold is not always fufficient to effect this, fince in the moft fevere frofts the air is very often ferene, and parts with little or none of its vapour for a very confiderable time. Neither can we admit the winds to have any confiderable agency in this matter, fince we find that blowing upon vapour is fo far from condenfing it, that it unites it more clofely with the air, and wind is found to be a great promoter of evaporation.

§ See *Chemiftry*, n° &c.

According to Rohault, the great caufe of rain is the heat of the air; which, after continuing for fome time near the earth, is raifed on high by a wind, and there thawing the fnowy villi or flocks of half-frozen veficulæ, reduces them to drops; which, coalefcing, defcend. Here, however, we ought to be informed by what means thefe veficulæ are fufpended in their half-frozen ftate; fince the thawing of them can make but little difference in their fpecific gravity, and it is certain that they afcended through the air not in a frozen but in an aqueous ftate.

Dr Clarke and others afcribe this defcent of the rain rather to an alteration of the atmofphere than of the veficulæ; and fuppofe it to arife from a diminution of the elaftic force of the air. This elafticity, which, they fay, depends chiefly or wholly upon terrene exhalations, being weakened, the atmofphere finks under its burden, and the clouds fall. Now, the little vefícles being once upon the defcent, will continue therein, notwithftanding the increafe of refiftance they every moment meet with. For, as they all tend to the centre of the earth, the farther they fall, the more coalitions they will make; and the more coalitions, the more matter will there be under the fame furface; the furface increafing only as the fquares, but the folidity as the cubes; and the more matter under the fame furface, the lefs refiftance will there be to the fame matter. Thus, if the cold, wind, &c. act early enough to precipitate the afcending veficles before they are arrived at any confiderable height, the coalitions being but few, the drops will be proportionably fmall; and thus is formed a dew. If the vapours be more copious, and rife a little higher, we have a mift or fog. A little higher ftill, and they produce a fmall rain; if they neither meet with cold nor wind, they form a heavy thick dark fky. This hypothefis is equally unfatisfactory with the others; for, granting that the defcent and condenfation of the vapours are owing to a diminution of the atmofphere's elafticity, by what is this diminution occafioned? To fay that it is owing to terrene exhalations, is only folving one difficulty by another; fince we are totally unacquainted both with the nature and operation of thefe exhalations. Befides, let us fuppofe the caufe to be what it will, if it acts equally and at once upon all the vapour in the air, then all that vapour muft be precipitated at once; and thus, inftead of gentle fhowers continuing for a confiderable length of time, we fhould have the moft violent water-fpouts, continuing only for a few minutes, or perhaps feconds, which, inftead of refrefhing the earth, would drown and lay wafte every thing before them.

Since philofophers have admitted the electric fluid to fuch a large fhare in the operations of nature, almoft all the natural phenomena have been accounted for by the action of that fluid; and rain, among others, has been reckoned an effect of electricity. But this word, unlefs it is explained, makes us no wifer than we were before; the phenomena of artificial electricity having been explained on principles which could fcarce apply in any degree to the electricity of nature: and therefore all the folution we can obtain of the natural appearances of which we fpeak, comes to this, that rain is occafioned by a moderate electrification, hail and fnow by one more violent, and thunder by the moft violent of all; but in what manner this electrification is occafioned, hath not yet been explained. Throughout the various parts of this work where electricity hath been occafionally mentioned, the principles of artificial electricity ‖, laid down in the treatife appropriated to that fubject, have been applied to the folution of the phenomena of nature; thofe which are neceffary to be attended to here are the following:

‖ See *Electricity*, n° 201, 216, &c.

1. The electric fluid and folar light are the fame fubftance in two different modifications.

2. Electricity is the motion of the fluid when running, or attempting to run, in a continued ftream from one place to another: heat is when the fluid has no tendency but to vibrate outwards and inwards to and from a centre; or at leaft when its ftreams converge to a point or focus.

3. The fluid acting as electricity, like water, or any other fluid, always tends to the place where there is leaft refiftance.

On thefe three principles may the phenomena of atmofpherical electricity, and the defcent of rain by its means, be explained as follows:

1 The light or heat of the fun, acting in that peculiar manner which we call *heat*, unites itfelf with the moifture of the earth, and forms it into vapour, which thus becomes fpecifically lighter than air, and of confequence afcends in the atmofphere to a certain height.

2. Befides the quantity of light which is thus united to the water, and forms it into vapour, a very confiderable quantity enters the earth, where it affumes the nature of electric fluid.

3. As the earth is always full of that fluid, every quantity which enters muft difplace an equal quantity which is already there.

4. This quantity which is difplaced muft efcape either at a diftance from the place where the other enters, or very near it.

5. At whatever place a quantity of electric matter efcapes, it muft electrify the air above that place where it has efcaped; and as a confiderable quantity of light muft always be reflected from the earth into the atmofphere, where it does not combine with the aqueous vapour, we have thence another fource of electricity to the air; as this quantity muft undoubtedly affume the action of electric fluid, efpecially after the action of the fun has ceafed. Hence the rea-

 fon

Rain.

fon why in ferene weather the atmofpherical electricity is always ftrongeft, and rather more fo in the night than in the day.

6. From thefe confiderations, we fee an evident reafon why there muft commonly be a difference between the electricity of the earth and that of the atmofphere, excepting when an earthquake is about to enfue. The confequence of this muft be, that as the action of the folar light continues to bring down the electric matter, and the earth continues to difcharge an equal quantity of it into the atmofphere, fome part of the atmofphere muft at laft become overloaded with it, and attempt to throw it back into the earth. This attempt will be vain, until a vent is found for the electricity at fome other place; and as foon as this happens, the electrified atmofphere begins to throw off its fuperfluous electricity, and the earth to receive it. As the atmofphere itfelf is a bad conductor, and the more fo the drier it is, the electric matter attacks the fmall aqueous particles which are detained in it by means of the latent heat. Thefe being unable to bear the impetus of the fluid, throw out their latent heat, which eafily efcapes, and thus makes a kind of vacuum in the electrified part of the atmofphere. The confequences of this are, that the aqueous particles being driven together in large quantity, at laft become vifible, and the fky is covered with clouds; at the fame time a wind blows againft thefe clouds, and, if there is no refiftance in the atmofphere, will drive them away.

7. But if the atmofphere all round the cloud is exceedingly electrified, and the earth is in no condition to receive the fuperfluous fluid excepting in that place which is directly under the cloud, then the whole electricity of the atmofphere for a vaft way round will tend to that part only, and the cloud will be electrified to an extreme degree. A wind will now blow againft the cloud from all quarters, more and more of the vapour will be extricated from the air by the electric matter, and the cloud will become darker and thicker, at the fame time that it is in a manner ftationary, as being acted upon by oppofite winds; though its fize is enlarged with great rapidity by the continual fupplies of vapour brought by the winds.

8. The vapours which were formerly fufpended invifibly by means of the latent heat are now fufpended vifibly by the electric fluid, which will not let them fall to the earth, until it is in a condition to receive the electric matter defcending with the rain.—It is eafy to fee, however, that thus every thing is prepared for a violent ftorm of thunder and lightning as well as rain. The furface of the earth becomes electrified from the atmofphere: but when this has continued for fome time, a zone of earth confiderably below the furface acquires an electricity oppofite to that of the clouds and atmofphere; of confequence the electricity in the cloud being violently preffed on all fides, will at laft burft out towards that zone where the refiftance is leaft, as explained under the article Lightning.—The vapours now having loft that which fupported them, will fall down in rain, if there is not a fufficient quantity of electric matter to keep them in the fame ftate in which they were before: but if this happens to be the cafe, the cloud will inftantly be charged again, while little or no rain will fall; and hence very violent thunder fometimes takes place without any rain at all, or fuch as is quite inconfiderable in quantity.

9. When the electricity is lefs violent, the rain will defcend in vaft quantity, efpecially after every flafh of lightning; and great quantities of electric matter will thus be conveyed to the earth, infomuch that fometimes the drops have been obferved to fhine as if they were on fire, which has given occafion to the reports of fiery rain having fallen on certain occafions. If the quantity of electric matter is fmaller, fo that the rain can convey it all gradually to the ground, there will be rain without any thunder; and the greater the quantity of electricity the more violent will be the rain.

From this account of the caufes of rain, we may fee the reafon why in warm climates the rains are exceffive, and for the moft part accompanied with thunder; for there the electricity of the atmofphere is immenfely greater than it is with us. We may alfo fee why in certain places, according to the fituation of mountains, feas, &c. the rains will be greater than in others, and likewife why fome parts of the world are exempted from rain altogether; but as a particular difcuffion of thefe would neceffarily include an explanation of the caufes and phenomena of Thunder, we fhall for this reafon refer the whole to be treated of under that article.

Whether this theory be juft, however, it would be too affuming in us to fay. It may admit of difpute, for we muft grant that in the very beft fyftems, though an occurrence fo frequent, the theory of rain is but very imperfectly underftood. Dr James Hutton, Fellow of the Royal Society of Edinburgh, whofe fpeculations are always ingenious, though generally extraordinary, and much out of the common way, gives us a new theory of rain in the firft volume of the Tranfactions of that fociety. It is well known that atmofpheric air is capable of diffolving, with a certain degree of heat, a given quantity of water. The Doctor afcertains the ratio of the diffolving power of air, in relation to water, in different degrees of heat; and fhows, that by mixing a portion of tranfparent humid warm air with a portion of cold air, the mixture becomes opake, and part of the water will be precipitated; or, in other words, the vapour will be condenfed into rain. The ratio which he ftates, however, does not appear to us to be fupported by experience. Whether the electricity of the air changes in confequence of its depofiting the water diffolved in it, or the change is a caufe of this depofition, muft remain uncertain; but, in either view, there muft be an agent different from heat and cold, fince the changes in thefe refpects do not in other operations change the ftate of electricity. Dr Hutton fuppofes that heat and folution do not increafe by equal increments; but that, in reality, if heat be fuppofed to increafe by equal increments along a ftraight line, folution will be expreffed by ordinates to a curve whofe convex fide is turned towards that line. That the power of folution is not increafed in the fame ratio with heat, is, however, hypothetical, except when we rife pretty high in the fcale, when its proportional increafe is a little doubtful; and it is not, in this paper, fupported by experiment. The condenfation of the breath in air is not an obfervation in point, except in air already faturated with vapour. It can amount, in any view, to no more than this, that to render it vifible, the heat muft be diminifhed

Rain.

minifhed in a greater proportion than can be compenfated by the power of folution in the body of air, in which the portion expired is at firft immerfed. To explain rain from this caufe, we muft always fuppofe a conftant diminution of heat to take place at the moment of the condenfation of the vapour; but we actually find that the change from a ftate of vapour to the fluid ftate is attended with heat; fo that rain muft at once oppofe its own caufe, and continued rains would be impoffible, without calling in the aid of other caufes. From his own fyftem, Dr Hutton endeavours to explain the regular and irregular feafons of rain, either refpecting the generality of its appearance, or the regularity of its return And to obviate the apparent exceptions of the theory, from the generality of rain, he explains the proportional quantities of rain, and adds a comparative eftimate of climates, in relation to rain, with the meteorological obfervations made in our own climate. As his principle is at leaft infufficient, and we think erroneous, it would be ufelefs, even were this a proper place for it, to purfue thefe various branches, which muft partake of the errors of the fyftem. In thefe branches we ought to obferve, that there are feveral juft obfervations, mixed with errors, becaufe evaporation and condenfation muft at laft be the great bafis of every theory: the miftakes arife from not being aware of all the caufes, and mifreprefenting the operation of thofe which do exift.

In a work entitled Thoughts on Meteorology, Volume II. M. de Luc confiders very particularly the grand phenomenon of rain, and the numerous circumftances connected with it. He examines the feveral hypothefes with confiderable care; but thinks them, even if admiffible, utterly infufficient to account for the formation of rain. The grand queftion in this inquiry is, What becomes of the water that rifes in vapour into the atmofphere? or what ftate it fubfifts in there, between the time of its evaporation and its falling down again in rain? If it continues in the ftate of watery vapour, or fuch as is the immediate product of evaporation, it muft poffefs the diftinctive characters effential to that fluid: it muft make the hygrometer move towards humidity, in proportion as the vapour is more or lefs abundant in the air: on a diminution of heat, the humidity, as fhown by the hygrometer, muft increafe; and on an increafe of the heat the humidity muft diminifh; and the introduction of other hygrofcopic fubftances, drier than the air, muft have the fame effect as an augmentation of heat. Thefe are the properties of watery vapour, on every hypothefis of evaporation; and therefore all the water that exifts in the atmofphere without poffeffing thefe properties, is no longer vapour, but muft have changed its nature. M. de Luc fhows, that the water which forms rain, though it has ever been confidered and reafoned upon as producing humidity, does not poffefs thefe properties, and muft therefore have paffed into another ftate. See a full account of his reafoning, and the fteps by which he proceeded, in the article METEOROLOGY, n° 7, &c. As he thinks that the vapour paffes into an invifible ftate in the interval between evaporation and its falling again in rain, and that in that ftate it is not fenfible to the hygrometer, he confiders the laws of hygrology as infufficient for explaining the formation of rain; but he does not pretend to have difcovered the immediate caufe of the formation of clouds and rain. If it is not in the immediate product of evaporation that rain has its fource; if the vapours change their nature in the atmofphere, fo as no longer to be fenfible to the hygrometer, or to the eye; if they do not become vapour again till clouds appear; and if, when the clouds are formed, no alteration is perceived in the quality of the air—we muft acknowledge it to be very probable, that the intermediate ftate of vapour is no other than air—and that the clouds do not proceed from any diftinct fluid contained in the atmofphere, but from a decompofition of a part of the air itfelf, perfectly fimilar to the reft.

It appears, to us at leaft, that M. de Luc's mode of reafoning on this fubject agrees better with the phenomena than Dr Hutton's. The Doctor, however, thinks differently, and publifhed anfwers to the objections of M. de Luc with regard to his theory of rain; to which M. de Luc replied in a letter which was printed in the Appendix to the 81ft volume of the Monthly Review: but it would extend our article beyond its due bounds, to give a view of this controverfy. See VAPOUR, WATER, WEATHER, and WIND.

As to the general quantity of rain that falls, and its proportion in feveral places at the fame time, and in the fame place at feveral times, we have many obfervations, journals, &c. in the Memoirs of the French Academy, the Philofophical Tranfactions, &c. Upon meafuring, then, the rain falling yearly, its depth, at a medium, and its proportion in feveral places, is found as in the following table:

	Inches.
At Townley, in Lancafhire, obferved by Mr Townley - - -	42½
Upminfter, in Effex, by Dr Derham -	19¼
Zurich, in Swifferland, by Dr Scheuchzer	32¼
Pifa, in Italy, by Dr Mich. Ang. Tilli -	43¼
Paris, in France, by M. de la Hire -	19
Lifle, in Flanders, by M. de Vauban -	24

	At Upminfter.		At Paris.	
1700	19 Inch.	.03	21 Inch.	.37
1701	18	.69	27	.77
1702	20	.38	17	.45
1703	23	.99	18	.51
1704	15	.80	21	.20
1705	16	.93	14	.82

From the Meteorological Journal of the Royal Society, kept by order of the prefident and council, it appears that the whole quantity of rain at London, in each of the years fpecified below, was as follows, viz.

		Inches.	
1774	- -	26	.328
1775	- -	24	.083
1776	- -	20	.354
1777	- -	25	.371
1778	- -	20	.772
1779	- -	26	.785
1780	- -	17	.313

The quantity of rain in the four following years at London was,

		Inches.	
In 1789	- -	21	.976
1790	- -	16	.052
1791	- -	15	.310
1792	- -	19	.489

Prov-

Rain.

Proportion of the Rain of the ſeveral Seaſons to one another.

1708	Depth at Piſa. Inch.	Depth at Upminſ. Inch.	Depth at Zurich. Inch.	1708	Depth at Piſa. Inch.	Depth at Upminſ. Inch.	Depth at Zurich. Inch.
Jan.	6 .41	2 .88	1 .64	July	0 .00	1 .11	3 .50
Feb.	3 .28	0 .46	1 .65	Aug.	2 .27	2 .94	3 .15
Mar.	2 .65	2 .03	1 .51	Sept.	7 .21	1 .46	3 .02
April	1 .25	0 .96	4 .69	Oct.	5 .33	0 .23	2 .44
May	3 .33	2 .02	1 .91	Nov.	0 .13	0 .86	0 .62
June	4 .90	2 .32	5 .91	Dec.	0 .00	1 .97	2 .62
Half Year	21 .82	10 .67	17 .31	Half Year	14 .94	8 .57	15 .35

See Philoſophical Tranſactions abridged, vol. iv. p. ii. p. 81, &c. and alſo Meteorological Journal of the Royal Society, publiſhed annually in the Philoſophical Tranſactions.

As to the uſe of rain, we may obſerve, that it moiſtens and ſoftens the earth, and thus fits it for affording nouriſhment to plants; by falling on high mountains, it carries down with it many particles of looſe earth, which ſerve to fertilize the ſurrounding valleys, and purifies the air from noxious exhalations, which tend in their return to the earth to meliorate the ſoil; it moderates the heat of the air; and is one means of ſupplying fountains and rivers. However, vehement rains in many countries are found to be attended with barrenneſs and poorneſs of the lands, and miſcarriage of the crops in the ſucceeding year: and the reaſon is plain; for theſe exceſſive ſtorms waſh away the fine mould into the rivers, which carry it into the ſea, and it is a long time before the land recovers itſelf again. The remedy to the famine, which ſome countries are ſubject to from this ſort of miſchief, is the planting large orchards and groves of ſuch trees as bear eſculent fruit; for it is an old obſervation, that in years, when grain ſucceeds worſt, theſe trees produce moſt fruit of all. It may partly be owing to the thorough moiſtening of the earth, as deep as their roots go by theſe rains, and partly to their trunks ſtopping part of the light mould carried down by the rains, and by this means furniſhing themſelves with a coat of new earth.

Preternatural Rains. We have numerous accounts, in the hiſtorians of our own as well as other countries, of preternatural rains; ſuch as the raining of ſtones, of duſt, of blood, nay, and of living animals, as young frogs, and the like. We are not to doubt the truth of what thoſe who are authors of veracity and credit relate to us of this kind, ſo far as to ſuppoſe that the falling of ſtones and duſt never happened; the whole miſtake is, the ſuppoſing them to have fallen from the clouds: but as to the blood and frogs, it is very certain that they never fell at all, but the opinion has been a mere deception of the eyes. Men are extremely fond of the marvellous in their relations; but the judicious reader is to examine ſtrictly whatever is reported of this kind, and is not to ſuffer himſelf to be deceived.

There are two natural methods by which quantities of ſtones and duſt may fall in certain places, without their having been generated in the clouds or fallen as rain. The one is by means of hurricanes: the wind which we frequently ſee tearing off the tiles of houſes, and carrying them to conſiderable diſtances, being equally able to take up a quantity of ſtones, and drop them again at ſome other place. But the other, which is much the moſt powerful, and probably the moſt uſual way, is for the eruptions of volcanoes and burning mountains to toſs up, as they frequently do, a vaſt quantity of ſtones, aſhes, and cinders, to an immenſe height in the air: and theſe, being hurried away by the hurricanes and impetuous winds which uſually accompany thoſe eruptions, and being in themſelves much lighter than common ſtones, as being half calcined, may eaſily be thus carried to vaſt diſtances; and there falling in places where the inhabitants know nothing of the occaſion, they cannot but be ſuppoſed by the vulgar to fall on them from the clouds. It is well known, that, in the great eruptions of Ætna and Veſuvius, ſhowers of aſhes, duſt, and ſmall cinders, have been ſeen to obſcure the air, and overſpread the ſurface of the ſea for a great way, and cover the decks of ſhips; and this at ſuch a diſtance, as it ſhould appear ſcarce conceivable that they ſhould have been carried to: and probably, if the accounts of all the ſhowers of theſe ſubſtances mentioned by authors be collected, they will all be found to have fallen within ſuch diſtances of volcanoes; and if compared as to the time of their falling, will be found to correſpond in that alſo with the eruptions of thoſe mountains. We have known inſtances of the aſhes from Veſuvius having been carried thirty, nay, forty leagues, and peculiar accidents may have carried them yet farther. It is not to be ſuppoſed that theſe ſhowers of ſtones and duſt fall for a continuance in the manner of ſhowers of rain, or that the fragments or pieces are as frequent as drops of water; it is ſufficient that a number of ſtones, or a quantity of duſt, fall at once on a place, where the inhabitants can have no knowledge of the part from whence they came, and the vulgar will not doubt their dropping from the clouds. Nay, in the canton of Berne in Swiſſerland, the inhabitants accounted it a miracle that it rained earth and ſulphur upon them at a time that a ſmall volcano terrified them; and even while the wind was ſo boiſterous, and hurricanes ſo frequent, that they ſaw almoſt every moment the duſt, ſand, and little ſtones torn up from the ſurface of the earth in whirlwinds, and carried to a conſiderable height in the air, they never conſidered that both the ſulphur thrown up by the volcano, and the duſt, &c. carried from their feet muſt fall ſoon after ſomewhere. It is very certain that in ſome of the terrible ſtorms of large hail, where the hail-ſtones have been of many inches round, on breaking them there have been found what people have called *ſtones in their middle;* but theſe obſervers needed only to have waited the diſſolving of one of theſe hail-ſtones, to have ſeen the ſtone in its centre diſunite alſo, it being only formed of the particles of looſe earthy matter, which the water, exhaled by the ſun's heat, had taken up in extremely ſmall moleculæ with it; and this only having ſerved to give an opake hue to the inner part of the congelation, to which the freezing of the water alone gave the apparent hardneſs of ſtone.

The raining of *blood* has been ever accounted a more terrible ſight and a more fatal omen than the other preternatural rains already mentioned. It is very certain that nature forms blood nowhere but in the veſſels of animals; and therefore ſhowers of it from the clouds are by no means to be credited. Thoſe who ſuppoſe that what has been taken for blood has been actually ſeen falling through the air, have had recourſe to flying inſects for its origin, and ſuppoſe it the eggs or dung of

certain butterflies diſcharged from them as they were high up in the air. But it ſeems a very wild conjecture, as we know of no butterfly whoſe excrements or eggs are of ſuch a colour, or whoſe abode is ſo high, or their flocks ſo numerous, as to be the occaſion of this.

It is moſt probable that theſe bloody waters were never ſeen falling; but that people ſeeing the ſtanding waters blood-coloured, were aſſured, from their not knowing how it ſhould elſe happen, that it had rained blood into them. A very memorable inſtance of this there was at the Hague in the year 1670. Swammerdam, who relates it, tells us, that one morning the whole town was in an uproar on finding their lakes and ditches full of blood, as they thought; and having been certainly full of water the night before, they agreed it muſt have rained blood in the night: but a certain phyſician went down to one of the canals, and taking home a quantity of this blood-coloured water, he examined it by the microſcope, and found that the water was water ſtill, and had not at all changed its colour; but that it was full of prodigious ſwarms of ſmall red animals, all alive, and very nimble in their motions, whoſe colour and prodigious number gave a red tinge to the whole body of the water they lived in, on a leſs accurate inſpection. The certainty that this was the caſe, did not however perſuade the Hollanders to part with the miracle: they prudently concluded, that the ſudden appearance of ſuch a number of animals was as great a prodigy as the raining of blood would have been; and are aſſured to this day, that this portent foretold the ſcene of war and deſtruction which Louis XIV. afterwards brought into that country, which had before enjoyed 40 years uninterrupted peace.

The animals which thus colour the water of lakes and ponds are the *pulices arboreſcentes* of Swammerdam, or the water-fleas with branched horns. Theſe creatures are of a reddiſh-yellow or flame colour: they live about the ſides of ditches, under weeds, and among the mud; and are therefore the leſs viſible, except at a certain time, which is in the end or beginning of June: it is at this time that theſe little animals leave their receſſes to float looſe about the water, to meet for the propagation of their ſpecies, and by that means become viſible in the colour they give the water. This is viſible, more or leſs, in one part or other of almoſt all ſtanding waters at this ſeaſon; and it is always at this ſeaſon that the bloody waters have alarmed the ignorant. See *Pulex Monoculus*.

The raining of *frogs* is a thing not leſs wonderful in the accounts of authors who love the marvellous, than thoſe of blood or ſtones; and this is ſuppoſed to happen ſo often, that there are multitudes who pretend to have been eye-witneſſes of it. Theſe rains of frogs always happen after very dry ſeaſons, and are much more frequent in the hotter countries than in the cold ones. In Italy they are very frequent; and it is not uncommon to ſee the ſtreets of Rome ſwarming both with young frogs and toads in an inſtant in a ſhower of rain; they hopping everywhere between the people's legs as they walk, though there was not the leaſt appearance of them before. Nay, they have been ſeen to fall through the air down upon the pavements. This ſeems a ſtrong circumſtance in favour of their being rained down from the clouds; but, when ſtrictly examined, it comes to nothing: for theſe frogs that are ſeen to fall, are always found dead, lamed, or bruiſed by the fall, and never hop about as the reſt; and they are never ſeen to fall, except cloſe under the walls of houſes, from the roofs and gutter of which they have accidentally ſlipped down. Some people, who love to add to ſtrange things yet ſtranger, affirm that they have had the young frogs fall into their hats in the midſt of an open field; but this is idle, and wholly falſe.

Others, who cannot agree to their falling from the clouds, have tried to ſolve the difficulty of their ſudden appearance, by ſuppoſing them hatched out of the egg, or ſpawn, by theſe rains. Nay, ſome have ſuppoſed them made immediately out of the duſt: but there are unanſwerable arguments againſt all theſe ſuppoſitions. Equivocal generation, or the ſpontaneous production of animals out of duſt, is now wholly exploded. The fall from the clouds muſt deſtroy and kill theſe tender and ſoft-bodied animals: and they cannot be at this time hatched immediately out of eggs; becauſe the young frog does not make its appearance from the egg in form, but has its hinder legs enveloped in a ſkin, and is what we call a *tadpole*; and the young frogs are at leaſt 100 times larger at the time of their appearance, than the egg from which they ſhould be hatched.

It is beyond a doubt, that the frogs which make their appearance at this time, were hatched and in being long before: but that the dry ſeaſons had injured them, and kept them ſluggiſhly in holes or coverts; and that all the rain does, is the enlivening them, giving them new ſpirits, and calling them forth to ſeek new habitations, and enjoy the element they were deſtined in great part to live in. Theophraſtus, the greateſt of all the naturaliſts of antiquity, has affirmed the ſame thing. We find that the error of ſuppoſing theſe creatures to fall from the clouds was as early as that author's time; and alſo that the truth, in regard to their appearance, was as early known; though, in the ages ſince, authors have taken care to conceal the truth, and to hand down to us the error. We find this venerable ſage, in a fragment of his on the generation of animals which appear on a ſudden, bantering the opinion, and aſſerting that they were hatched and living long before. The world owes, however, to the accurate Signior Redi the great proof of this truth, which Theophraſtus only has affirmed: for this gentleman, diſſecting ſome of theſe new-appearing frogs, found in their ſtomachs herbs and other half-digeſted food; and, openly ſhowing this to his credulous countrymen, aſked them whether they thought that nature, which engendered, according to their opinion, theſe animals in the clouds, had alſo been ſo provident as to engender graſs there for their food and nouriſhment?

To the raining of frogs we ought to add the raining of *graſshoppers* and *locuſts*, which have ſometimes appeared in prodigious numbers, and devoured the fruits of the earth. There has not been the leaſt pretence for the ſuppoſing that theſe animals deſcended from the clouds, but that they appeared on a ſudden in prodigious numbers. The naturaliſt, who knows the many accidents attending the eggs of theſe and other the like animals, cannot but know that ſome ſeaſons will prove particularly favourable to the hatching them, and the prodigious number of eggs that many inſects lay could not but every year bring us ſuch abundance of the young, were they not liable to many accidents, and had not provident nature taken care, as in many plants, to continue the

Rain. the fpecies by a very numerous ftock of feeds, of which perhaps not one in 500 need take root in order to continue an equal number of plants. As it is thus alfo in regard to infects, it cannot but happen, that if a favourable feafon encourage the hatching of all thofe eggs, a very fmall number of which alone were neceffary to continue the fpecies, we muft, in fuch feafons, have a proportionate abundance of them. There appeared about 50 years ago, in London, fuch a prodigious fwarm of the little beetle we call the *lady-cow*, that the very pofts in the ftreets were everywhere covered with them. But thanks to the progrefs of philofophy among us, we had no body to affert that it rained cow-ladies, but contented ourfelves with faying that it had been a favourable feafon for their eggs. The prodigious number of a fort of grub which did vaft mifchief about the fame period among the corn and grafs by eating off their roots, might alfo have been fuppofed to proceed from its having rained grubs by people fond of making every thing a prodigy; but our knowledge in natural hiftory affured us, that thefe were only the hexapode worms of the common hedge-beetle called the *cock-chafer*.

The raining of *fifhes* has been a prodigy alfo much talked of in France, where the ftreets of a town at fome diftance from Paris, after a terrible hurricane in the night, which tore up trees, blew down houfes, &c. were found in a manner covered with fifhes of various fizes. Nobody here made any doubt of thefe having fallen from the clouds; nor did the abfurdity of fifh, of five or fix inches long, being generated in the air, at all ftartle the people, or fhake their belief in the miracle, till they found, upon inquiry, that a very well-ftocked fifh-pond, which ftood on an eminence in the neighbourhood, had been blown dry by the hurricane, and only the great fifh left at the bottom of it, all the fmaller fry having been toffed into their ftreets.

Upon the whole, all the fuppofed marvellous rains have been owing to fubftances naturally produced on the earth, and either never having been in the air at all, or only carried thither by accident.

In Silefia, after a great dearth of wheat in that country, there happened a violent ftorm of wind and rain, and the earth was afterwards covered, in many places, with fmall round feeds. The vulgar cried out that Providence had fent them food, and that it had rained *millet*: but thefe were, in reality, only the feeds of a fpecies of veronica, or fpeed-well, very common in that country; and whofe feeds being juft ripe at that time, the wind had diflodged them from their capfules, and fcattered them about. In our own country, we have hiftories of rains of this marvellous kind, but all fabulous. It was once faid to rain *wheat* in Wiltfhire; and the people were all alarmed at it as a miracle, till Mr Cole fhowed them, that what they took for wheat was only the feeds or kernels of the berries of ivy, which being then fully ripe, the wind had diflodged from the fides of houfes, and trunks of trees, on which the ivy that produced them crept.

And we even once had a raining of fifhes near the coaft of Kent in a terrible hurricane, with thunder and lightning. The people who faw fmall fprats ftrewed all about afterwards, would have it that they had fallen from the clouds; but thofe who confidered how far the high winds have been known to carry the fea-water, did not wonder that they fhould be able to carry fmall fifh with it fo fmall a part of the way. Rain.

In the Philofophical Tranfactions for 1782 we have the following account of a preternatural kind of rain by Count de Gioeni: "The morning of the 24th inftant there appeared here a moft fingular phenomenon. Every place expofed to the air was found wet with a coloured cretaceous grey water, which, after evaporating and filtrating away, left every place covered with it to the height of two or three lines; and all the iron-work that was touched by it became rufty.

"The public, inclined to the marvellous, fancied various caufes of this rain, and began to fear for the animals and vegetables.

"In places where rain-water was ufed, they abftained from it: fome fufpecting vitriolic principles to be mixed with it, and others predicting fome epidemical diforder.

"Thofe who had obferved the explofions of Etna 20 days and more before, were inclined to believe it originated from one of them.

"The fhower extended from N. $\frac{1}{4}$ N. E. to S. $\frac{1}{4}$ S. W. over the fields, about 70 miles in a right line from the vertex of Etna.

"There is nothing new in volcanos having thrown up fand, and alfo ftones, by the violent expanfive force generated within them, which fand has been carried by the wind to diftant regions.

"But the colour and fubtilty of the matter occafioned doubts concerning its origin; which increafed from the remarkable circumftance of the water in which it came incorporated; for which reafons fome other principle or origin was fufpected.

"It became, therefore, neceffary by all means to afcertain the nature of this matter, in order to be convinced of its origin, and of the effects it might produce. This could not be done without the help of a chemical analyfis. To do this then with certainty, I endeavoured to collect this rain from places where it was moft probable no heterogeneous matter would be mixed with it. I therefore chofe the plant called *braffica capitata*, which having large and turned-up leaves, they contained enough of this coloured water: many of thefe I emptied into a veffel, and left the contents to fettle till the water became clear.

"This being feparated into another veffel, I tried it with vegetable alkaline liquors and mineral acids; but could obferve no decompofition by either. I then evaporated the water in order to reunite the fubftances that might be in folution; and touching it again with the aforefaid liquors, it fhowed a flight effervefcence with the acids. When tried with the fyrup of violets, this became a pale green; fo that I was perfuaded it contained a calcareous falt. With the decoction of galls no precipitation was produced.

"The matter being afterwards dried in the fhade, it appeared a very fubtile fine earth, of a cretaceous colour, but inert, from having been diluted by the rain.

"I next thought of calcining it with a flow fire, and it affumed the colour of a brick. A portion of this being put into a crucible, I applied to it a ftronger heat; by which it loft almoft all its acquired colour. Again, I expofed a portion of this for a longer time to a very violent heat (from which a vitrification might be expected);

Rain, Rainbow.

expected); it remained, however, quite soft, and was easily bruised, but returned to its original dusky colour.

"From the most accurate observations of the smoke from the three calcinations, I could not discover either colour or smell that indicated any arsenical or sulphureous mixture.

"Having therefore calcined this matter in three portions, with three different degrees of fire, I presented a good magnet to each: it did not act either on the first or second; a slight attraction was visible in many places on the third: this persuaded me, that this earth contains a martial principle in a metallic form, and not in a vitriolic substance.

"The nature of these substances then being discovered, their volcanic origin appears; for iron, the more it is exposed to violent calcination, the more it is divided by the loss of its phlogistic principle; which cannot naturally happen but in the great chimney of a volcano. Calcareous salt, being a marine salt combined with a calcareous substance by means of violent heat, cannot be otherwise composed than in a volcano.

"As to their dreaded effects on animals and vegetables, every one knows the advantageous use, in medicine, both of the one and the other, and this in the same form as they are thus prepared in the great laboratory of nature.

"Vegetables, even in flower, do not appear in the least macerated, which has formerly happened from only showers of sand.

"How this volcanic production came to be mixed with water may be conceived in various ways.

"Ætna, about its middle regions, is generally surrounded with clouds that do not always rise above its summit, which is 2900 paces above the level of the sea. This matter being thrown out, and descending upon the clouds below it, may happen to mix and fall in rain with them in the usual way. It may also be conjectured, that the thick smoke which the volcanic matter contained might, by its rarefaction, be carried in the atmosphere by the winds over that tract of country; and then cooling so as to condense and become specifically heavier than the air, might descend in that coloured rain.

"I must, however, leave to philosophers (to whom the knowledge of natural agents belongs) the examination and explanation of such phenomena, confining myself to observation and chemical experiments."

Rain, a well built and fortified town of Bavaria, one of the keys of this electorate, on the Lech, 20 miles west of Ingolstadt. N. Lat. 48. 51. E. Long. 11. 12.

Rain-Bird. See Cuculus, n° 8.

RAINBOW. See Optics, Part II. Sect. i. § 1.

In the Philosophical Transactions for 1793, we have the following account of two rainbows seen by the Rev. Mr Sturges.

"On the evening of the 9th of July 1792, between seven and eight o'clock, at Alverstoke, near Gosport, on the sea-coast of Hampshire, there came up, in the south-east, a cloud with a thunder-shower; while the sun shone bright, low in the horizon to the north-west.

Plate CCCCXVII. fig. 2.

"In this shower two primary rainbows appeared, AB and AC, not concentric, but touching each other at A, in the south part of the horizon; with a secondary bow to each, DE and DF (the last very faint, but discernible), which touched likewise at D. Both the primary were very vivid for a considerable time, and at different times nearly equally so; but the bow AB was most permanent, was a larger segment of a circle, and at last, after the other had vanished, became almost a semicircle; the sun being near setting. It was a perfect calm, and the sea was as smooth as glass.

"If I might venture to offer a solution of this appearance, it would be as follows. I consider the bow AB as the true one, produced by the sun itself; and the other, AC, as produced by the reflection of the sun from the sea, which, in its perfectly smooth state, acted as a speculum. The direction of the sea, between the Isle of Wight and the land, was to the north-west in a line with the sun, as it was then situated. The image reflected from the water, having its rays issuing from a point lower than the real sun, and in a line coming from beneath the horizon, would consequently form a bow higher than the true one AB. And the shores, by which that narrow part of the sea is bounded, would before the sun's actual setting intercept its rays from the surface of the water, and cause the bow AC, which I suppose to be produced by the reflection, to disappear before the other."

The marine or sea bow is a phenomenon which may be frequently observed in a much agitated sea, and is occasioned by the wind sweeping part of the waves, and carrying them aloft; which when they fall down are refracted by the sun's rays, which paint the colours of the bow just as in a common shower. These bows are often seen when a vessel is sailing with considerable force, and dashing the waves around her, which are raised partly by the action of the ship and partly by the force of the wind, and, falling down, they form a rainbow; and they are also often occasioned by the dashing of the waves against the rocks on shore.

In the Philosophical Transactions, it is observed by F. Bourzes, that the colours of the marine rainbow are less lively, less distinct, and of shorter continuance, than those of the common bow; that there are scarce above two colours distinguishable, a dark yellow on the side next the sun, and a pale green on the opposite side. But they are more numerous, there being sometimes 20 or 30 seen together.

To this class of bows may be referred a kind of white or colourless rainbows, which Mentzelius and others affirm to have seen at noon-day. M. Marlotte, in his fourth *Essai de Physique*, says, these bows are formed in mists, as the others are in showers; and adds, that he has seen several both after sun-rising and in the night. The want of colours he attributes to the smallness of the vapours which compose the mist; but perhaps it is rather from the exceeding tenuity of the little vesiculæ of the vapour, which being only little watery pellicles bloated with air, the rays of light undergo but little refraction in passing out of air into them; too little to separate the differently coloured rays, &c. Hence the rays are reflected from them, compounded as they came, that is, white. Rohault mentions* coloured rainbows on the grass; formed by the refractions of the sun's rays in the morning dew. Rainbows have been also produced by the reflection of the sun from a river; and in the Philosophical Transactions, Vol. L. p. 294. we have

* *Trait. de Physique.*

Rainbow. have an account of a rainbow, which muſt have been formed by the exhalations from the city of London, when the ſun had been ſet 20 minutes, and conſequently the centre of the bow was above the horizon. The colours were the ſame as in the common rainbow, but fainter.

It has often been made a ſubject of inquiry among the curious how there came to be no rainbow before the flood, which is thought by ſome to have been the caſe from its being made a ſign of the covenant which the Deity was pleaſed to make with man after that event. Mr Whitehurſt, in his *Inquiry into the Original State and Formation of the Earth*, p. 173, &c. endeavours to eſtabliſh it as a matter of great probability at leaſt, that the antediluvian atmoſphere was ſo uniformly temperate as never to be ſubject to ſtorms, tempeſts, or rain, and of courſe it could never exhibit a rainbow. For our own part, we cannot ſee how the earth at that period could do without rain any more than at preſent; and it appears to us from Scripture equally probable that the rainbow was ſeen before the flood as after it. It was then, however, made a token of a certain covenant; and it would unqueſtionably do equally well for that purpoſe if it had exiſted before as if it had not.

Lunar Rainbow. The moon ſometimes alſo exhibits the phenomenon of an iris or rainbow by the refraction of her rays in drops of rain in the night-time. This phenomenon is very rare. In the Philoſophical Tranſactions for 1783, however, we have an account of three ſeen in one year, and all in the ſame place, communicated in two letters by Marmaduke Tunſtall, Eſq. The firſt was ſeen 27th February 1782, at Greta Bridge, Yorkſhire, between ſeven and eight at night, and appeared "in tolerably diſtinct colours, ſimilar to a ſolar one, but more faint: the orange colour ſeemed to predominate. It happened at full moon; at which time alone they are ſaid to have been always ſeen. Though Ariſtotle is ſaid to have obſerved two, and ſome others have been ſeen by Suellius, &c. I can only find two deſcribed with any accuracy; viz. one by Plot, in his Hiſtory of Oxfordſhire, ſeen by him in 1675, though without colours; the other ſeen by a Derbyſhire gentleman at Glapwell, near Cheſterfield, deſcribed by Thoreſby, and inſerted in N° 331. of the Philoſophical Tranſactions: this was about Chriſtmas, 1710, and ſaid to have had all the colours of the Iris Solaris. The night was windy; and though there was then a drizzling rain and dark cloud, in which the rainbow was reflected, it proved afterwards a light froſt."

Two others were afterwards ſeen by Mr Tunſtall; one on July the 30th, about 11 o'clock, which laſted about a quarter of an hour, without colours. The other, which appeared on Friday October 18. was "perhaps the moſt extraordinary one of the kind ever ſeen. It was firſt viſible about nine o'clock, and continued, tho' with very different degrees of brilliancy, till paſt two. At firſt, though a ſtrongly marked bow, it was without colours; but afterwards they were very conſpicuous and vivid in the ſame form as in the ſolar, though fainter; the red, green, and purple, were moſt diſtinguiſhable. About twelve it was the moſt ſplendid in appearance; its arc was conſiderably a ſmaller ſegment of a circle than a ſolar; its ſouth-eaſt limb firſt began to fail, and a conſiderable time before its final extinction: the wind was very high, nearly due weſt, moſt part of the time, accompanied with a drizzling rain. It is a ſingular circumſtance, that three of theſe phenomena ſhould have been ſeen in ſo ſhort a time in one place, as they have been eſteemed ever ſince the time of Ariſtotle, who is ſaid to have been the firſt obſerver of them, and ſaw only two in 50 years, and ſince by Plot and Thoreſby, almoſt the only two Engliſh authors who have ſpoke of them, to be exceeding rare. They ſeem evidently to be occaſioned by a refraction in a cloud or turbid atmoſphere, and in general are indications of ſtormy and rainy weather: ſo bad a ſeaſon as the late ſummer having, I believe, ſeldom occurred in England. Thoreſby, indeed, ſays, the one he obſerved was ſucceeded by ſeveral days of fine ſerene weather. One particular, rather ſingular, in the ſecond, viz. of July the 30th, was its being ſix days after the full of the moon; and the laſt, though of ſo long a duration, was three days before the full: that of the 27th of February was exactly at the full, which uſed to be judged the only time they could be ſeen, though in the Encyclopedia there is an account that Weidler obſerved one in 1719, in the firſt quarter of the moon, with faint colours, and in very calm weather. No lunar iris, I ever heard or read of, laſted near ſo long as that on the 18th inſtant, either with or without colours."

In the Gentleman's Magazine for Auguſt 1788 we have an account of a lunar rainbow by a correſpondent who ſaw it. "On Sunday evening the 17th of Auguſt (ſays he), after two days, on both of which, particularly the former, there had been a great deal of rain, together with lightning and thunder, juſt as the clocks were ſtriking nine, 23 hours after full moon, looking through my window, I was ſtruck with the appearance of ſomething in the ſky, which ſeemed like a rainbow. Having never ſeen a rainbow by night, I thought it a very extraordinary phenomenon, and haſtened to a place where there were no buildings to obſtruct my view of the hemiſphere: here I found that the phenomenon was no other than a lunar rainbow; the moon was truly 'walking in brightneſs,' brilliant as ſhe could be; not a cloud was to be ſeen near her; and over-againſt her, toward the north-weſt, or perhaps rather more to the north, was a rainbow, a vaſt arch, perfect in all its parts, not interrupted or broken as rainbows frequently are, but unremittedly viſible from one horizon to the other. In order to give ſome idea of its extent, it is neceſſary to ſay, that as I ſtood toward the weſtern extremity of the pariſh of Stoke Newington, it ſeemed to take its riſe from the weſt of Hampſtead, and to the end, perhaps, in the river Lea, the eaſtern boundary of Tottenham; its colour was white, cloudy, or greyiſh, but a part of its weſtern leg ſeemed to exhibit tints of a faint ſickly green. I continued viewing it for ſome time, till it began to rain; and at length the rain increaſing, and the ſky growing more hazy, I returned home about a quarter or 20 minutes paſt nine, and in ten minutes came out again; but by that time all was over, the moon was darkened by clouds, and the rainbow of courſe vaniſhed."

Marine Rainbow, or *Sea-bow*. See the article Rainbow.

Rainbow-Stone. See *Moon-Stone*.

Raiſins. RAISINS, grapes prepared by ſuffering them to remain on the vine till they are perfectly ripe, and then drying them in the ſun, or by the heat of an oven.

 The

The difference between raisins dried in the sun and those dried in ovens, is very obvious: the former are sweat and pleasant, but the latter have a latent acidity with the sweetness that renders them much less agreeable.

The common way of drying grapes for raisins, is to tie two or three bunches of them together while yet on the vine, and dip them into a hot lixivium of wood-ashes, with a little of the oil of olives in it. This disposes them to shrink and wrinkle; and after this they are left on the vine three or four days separated on sticks in an horizontal situation, and then dried in the sun at leisure, after being cut from the tree. The finest and best raisins are those called in some places *Damascus* and *Jube raisins;* which are distinguished from the others by their size and figure: they are flat and wrinkled on the surface, soft and juicy within, and near an inch long; and, when fresh and growing on the bunch, are of the size and shape of a large olive.

The raisins of the sun, and jar-raisins, are all dried by the heat of the sun; and these are the sorts used in medicine. However, all the kinds have much the same virtues: they are all nutritive and balsamic; they are allowed to be attenuant, are said to be good in nephritic complaints, and are an ingredient in pectoral decoctions: in which cases, as also in all others where astringency is not required of them, they should have the stones carefully taken out.

Raisin-Wine. See Wine.

RAKKATH (anc. geog.), a town of Upper Galilee, thought to be Tiberias, (Talmud): but this is denied by Reland, who says that Rakkath was a town of the tribe of Naphthali.

RAKE is a well known instrument with teeth, by which the ground is divided. See Agriculture, p. 318.

Rake also means a loose, disorderly, vicious, and thoughtless fellow.

Rake of a Ship, is all that part of her hull which hangs over both ends of her keel. That which is before is called the *fore rake*, or *rake forward*, and that part which is at the setting on of the stern-post is called the *rake-aft*, or *afterward*.

RALEIGH (Sir Walter), fourth son of Walter Raleigh, Esq; of Fardel, in the parish of Cornwood in Devonshire, was born in 1552 at Hayes, in the parish of Budley, a farm belonging to his father. About the year 1568, he was sent to Oriel college in Oxford, where he continued but a short time; for in the following year he embarked for France, being one of the hundred volunteers, commanded by Henry Champernon, who, with other English troops, were sent by queen Elisabeth to assist the queen of Navarre in defending the Protestants. In this service he continued for five or six years; after which he returned to London, and probably resided in the Middle Temple. But his enterprising genius would not suffer him to remain long in a state of inactivity. In 1577 or 1578, he embarked for the Low Countries with the troops sent by the queen to assist the Dutch against the Spaniards, and probably shared the glory of the decisive victory over Don John of Austria in 1578. On his return to England, a new enterprise engaged his attention. His half-brother, Sir Humphrey Gilbert, having obtained a patent to plant and inhabit some parts of North America, Mr Raleigh embarked in this adventure; but, meeting with a Spanish fleet, after a smart engagement they returned, without success, in 1579.

The following year, the king of Spain, in conjunction with the pope, having projected a total conquest of the English dominions, sent troops to Ireland to assist the Desmonds in the Munster rebellion. Raleigh obtained a captain's commission under Lord Grey of Wilton, then deputy of Ireland, and embarked for that kingdom; where, by his conduct and resolution, he was principally instrumental in putting an end to the rebellious attempt. He returned to England; and attracted the notice of queen Elisabeth, owing, as we are told in Naunton's *Fragmenta Regalia*, to the following accidental piece of gallantry. The queen, as she was one day taking a walk, being stopped by a *plashy* place in the road, our gallant young soldier took off his new plush mantle, and spread it on the ground. Her majesty trod gently over the fair foot-cloth, surprised and pleased with the adventure. He was a handsome man, and remarkable for his gentility of address.

The queen admitted him to her court, and employed him first as an attendant on the French ambassador Simier on his return home, and afterward to escort the duke of Anjou to Antwerp. During this excursion he became personally known to the prince of Orange; from whom, at his return, he brought special acknowledgments to the queen, who now frequently conversed with him. But the inactive life of a courtier did not suit the enterprising spirit of Mr Raleigh. In the year 1583, he embarked with his brother, Sir Humphrey Gilbert, on a second expedition to Newfoundland, in a ship called the *Raleigh*, which he built at his own expence; but was obliged to return on account of an infectious distemper on board. He was, however, so little affected by this disappointment, that he now laid before the queen and council a proposal for exploring the continent of North America; and in 1584 obtained a patent empowering him to possess such countries as he should discover in that part of the globe. Accordingly Mr Raleigh fitted out two ships at his own expence, which sailed in the month of April, and returned to England about the middle of September, reporting that they had discovered and taken possession of a fine country called *Windangocoa*, to which the queen gave the name of *Virginia*. About this time he was elected knight of the shire for the county of Devon, and soon after received the honour of knighthood; and to enable him to carry on his designs abroad, the queen granted him a patent for licensing the venders of wine throughout the kingdom. In 1585 he sent a fleet of seven ships to Virginia, commanded by his relation Sir Richard Greenville, who left a colony at Roanah of 107 persons, under the government of Mr Lane; and by the establishment of this colony he first imported tobacco into England. See Nicotiana. In the same year Sir Walter Raleigh obtained a grant of 12,000 acres of the forfeited lands in the county of Corke in Ireland.—About the same time he was made seneschal of the duchy of Cornwall, and warden of the stanneries; and grew into such favour with the queen, that even Leicester was jealous of his influence.

In 1587, he sent another colony of 150 men to Virginia, with a governor, Mr John White, and 12 assistants. About this time we find our knight distinguish-

 ed

Raleigh. ed by the titles of *Captain of the queen's guards*, and *Lieutenant general of Cornwall.* From this period to the year 1594, he was continually engaged in projecting new expeditions, fending fuccours to colonies abroad, defending the kingdom from the infults of the Spaniards, and tranfacting parliamentary bufinefs, with equal ability and refolution. Whilft thus employed, he was publicly charged, in a libel written by the infamous Jefuit Parfons, with being an Atheift; a groundlefs and ridiculous imputation. In 1594, he obtained from the queen a grant of the manor of Sherborne in Dorfetfhire, where he built a magnificent houfe: but Sir Walter fell under the queen's difpleafure on account of an intrigue with the daughter of Sir Nicholas Throgmorton, one of the maids of honour; however, he married the lady, and lived with her in great conjugal harmony. During his difgrace at court, he projected the conqueft of Guiana in South America, and in 1595 failed for that country; of which having taken poffeffion, after defeating the Spaniards who were fettled there, he returned to England the fame year, and foon after publifhed an account of his expedition. In the following year he was one of the admirals in the fuccefsful expedition againft Cadiz, under the command of Howard and the earl of Effex; and in 1597 he failed with the fame commanders againft the Azores. Soon after thefe expeditions, we find him affiduoufly engaged in parliamentary bufinefs, and a diftinguifhed perfonage in joufts and tournaments. In 1600 he was fent on a joint embaffy with Lord Cobham to Flanders, and at his return made governor of Jerfey.

Queen Elifabeth died in the beginning of the year 1603; and with her Raleigh's glory and felicity funk, never to rife again. Upon the acceffion of James, Sir Walter loft his intereft at court, was ftripped of his preferments, and accufed of a plot againft the king. He was arraigned at Winchefter, and, on his trial, infulted by the moft fhocking brutality by the famous Coke, attorney-general, whofe fophiftical vociferation influenced the jury to convict him without the leaft proof of guilt. After a month's imprifonment, however, in daily expectation of his execution, he was reprieved, and fent to the Tower; and his eftates were given to Car, earl of Somerfet, the king's favourite. During this confinement, he wrote many of his moft valuable pieces, particularly his Hiftory of the World. In March 1615, after 16 years imprifonment, he obtained his liberty, and immediately began to prepare for another voyage to Guiana. In Auguft 1616, the king granted him a very ample commiffion for that purpofe; and in July the year following, he failed from Plymouth: but, ftrange as it may appear, it is moft certain that the whole fcheme was revealed to the Spaniards by the king himfelf, and thus neceffarily rendered abortive.

He returned to England in 1618, where he was foon after feized, imprifoned, and beheaded; not for any pretended mifdemeanor on the late expedition, but in confequence of his former attainder. The truth of the matter is, he was facrificed by the pufillanimous monarch to appeafe the Spaniards; who, whilft Raleigh lived, thought every part of their dominions in danger. He was executed in Old Palace Yard, and buried in St Margaret's adjoining, in the 66th year of his age. His behaviour on the fcaffold was manly, unaffected, cheerful, and eafy. Being afked by the executioner which way he would lay his head, he anfwered, "So the heart be right, it is no matter which way the head lies." He was a man of admirable parts, extenfive knowledge, undaunted refolution, and ftrict honour and honefty. He was the author of a great many works, fome of which have not been printed.

Rallus. RALLUS, the RAIL, in ornithology; a genus belonging to the order of grallæ. The beak is thickeft at the bafe, compreffed, equal, acute, and fomewhat fharp on the back near the point; the noftrils are oval; the feet have four toes, without any web; and the body is compreffed. Mr Latham, in his *Index Ornithologicus*, enumerates 24 fpecies, befides fome varieties. They are chiefly diftinguifhed by their colour. "Thefe birds (fays Buffon) conftitute a large family, and their habits are different from thofe of the other fhore-birds, which refide on fands and gravel. The rails, on the contrary, inhabit only the flimy margins of pools and rivers, efpecially low grounds covered with flags and other large marfh plants. This mode of living is habitual and common to all the fpecies of water-rails. The land rail frequents meadows, and from the difagreeable cry, or rather rattling in the throat of this bird, is derived the generic name. In all the rails, the body is flender, and fhrunk at the fides; the tail extremely fhort; the head fmall; the bill pretty like that of the gallinaceous kind, though much longer, and not fo thick; a portion of the leg above the knee is bare; the three fore-toes without membranes, and very long: they do not, like other birds, draw their feet under their belly in flying, but allow them to hang down: their wings are fmall and very concave, and their flight is fhort.— They feem to be more diffufed than varied; and nature has produced or tranfported them over the moft diftant lands. Captain Cook found them at the Straits of Magellan; in different iflands of the fouthern hemifphere, at Anamoka, at Tanna, and at the ifle of Norfolk. In the Society Iflands there are two fpecies of rails; a little black fpotted one, *(pooa-née)*, and a little red-eyed one *(mai-ho)*. It appears that the two acolins of Fernandez, which he denominates *water-quails*, are of a fpecies of rails peculiar to the great lake of Mexico.— The colins, which might be confounded with thefe, are a kind of partridges." The principal are,

1. The aquaticus, or water-rail, is a bird of a long flender body, with fhort concave wings. It delights lefs in flying than running: which it does very fwiftly along the edges of brooks covered with bufhes: as it runs, it every now and then flirts up its tail, and in flying hangs down its legs; actions it has in common with the water-hen. Its weight is four ounces and a half. The length to the end of the tail is 12 inches; the breadth 16. The bill is flender, flightly incurvated, one inch three quarters long: the upper mandible black, edged with red; the lower, orange-coloured: the head, hind part of the neck, the back, and coverts of the wings and tail, are black, edged with an olive brown; the throat, breaft, and upper part of the belly, are afh-coloured: the fides under the wings as far as the rump, finely varied with black and white bars. The tail is very fhort, confifts of 12 black feathers; the ends of the two middle tipt with ruft colour; the feathers immediately beneath the tail white. The legs are placed far behind, and are of a dufky flefh-colour. The toes very long, and divided to their very origin; though the feet are not webbed, it takes the water; will fwim on it with much eafe, but is often obferved to

to run along the furface. "Water rails (fays Buffon) are feen near the perennial fountains during the greateft part of the winter, yet like the land rails they have their regular migrations. They pafs Malta in the fpring and autumn. The Vifcount de Querhoent faw fome 50 leagues off the coafts of Portugal on the 17th of April. They were fo fatigued, that they fuffered themfelves to be caught by the hand (A). Gmelin found thefe birds in the countries watered by the Don. Belon calls them *black rails*, and fays they are everywhere known, and that the fpecies is more numerous than the red rail, or land rail. The flefh of the water rail is not fo delicate as that of the land rail, and has even a marfhy tafte, nearly like that of the gallinule. It continues the whole year in England."

2. The porzana, or gallinule, is not very frequent in Great Britain, and is faid to be migratory. Inhabits the fides of fmall ftreams, concealing itfelf among the bufhes. Its length is nine inches; its breadth, 15; its weight, four ounces five drachms. The head is brown, fpotted with black; the neck a deep olive, fpotted with white: the feathers of the back are black next their fhafts, then olive-coloured, and edged with white; the fcapulars are olive, finely marked with two fmall white fpots on each web: the legs of a yellowifh green. "Its habits (fays Buffon) wild, its inftinct ftupid, the porzana is unfufceptible of education, nor is even capable of being tamed. We raifed one, however, which lived a whole fummer on crumbs of bread and hemp-feed; when by itfelf, it kept conftantly in a large bowl of water; but if a perfon entered the clofet where it was fhut, it ran to conceal itfelf in a fmall dark corner, without venting cries or murmurs. In the ftate of liberty, however, it has a fharp piercing voice, much like the fcream of a young bird of prey; and though it has no propenfity to fociety, as foon as one cries, another repeats the found, which is thus conveyed through all the reft in the diftrict. Like all the rails, it is fo obftinately averfe to rife, that the fportfman often feizes it with his hand, or fells it with a ftick. If it finds a bufh in its retreat, it climbs upon it, and from the top of its afylum beholds the dogs brufhing along in fault: this habit is common to it and to the water-rail. It dives, fwims, and even fwims under water, when hard pufhed.

"Thefe birds difappear in the depth of winter, but return early in the fpring; and even in the month of February they are common in fome provinces of France and Italy. Their flefh is delicate, and much efteemed: thofe, in particular, which are caught in the rice-fields in Piedmont are very fat, and of an exquifite flavour."

3. The crex, crake, or corn-crek, has been fuppofed by fome to be the fame with the water-rail, and that it differs only by a change of colour at a certain feafon of the year: this error is owing to inattention to their characters and nature, both which differ entirely. The bill of this fpecies is fhort, ftrong, and thick; formed exactly like that of the water-hen, and makes a generical diftinction. It never frequents watery places; but is always found among corn, grafs, broom, or furze. It quits the kingdom before winter; but the water-rail endures our fharpeft feafons. They agree in their averfion to flight; and the legs, which are remarkably long for the fize of the bird, hang down whilft they are on the wing; they truft their fafety to their fwiftnefs on foot, and feldom are fprung a fecond time but with great difficulty. The land rail lays from 12 to 20 eggs, of a dull white colour, marked with a few yellow fpots; notwithftanding this, they are very numerous in this kingdom. Their note is very fingular; and like the quail, it is decoyed into a net by the imitation of its cry, *crěk crěk crěk*, by rubbing hard the blade of a knife on an indented bone. Moft of the names given in different languages to this bird are evidently formed to imitate this fingular cry. Hence Turner and fome other naturalifts have fuppofed it to be the crex of the ancients; but that term appears to have been applied by the ancients to other birds. Philus gives the crex the epithet of βραδυπτερος, or *fluggifh-winged*, which would indeed fuit the land-rail. Ariftophanes reprefents it as migrating from Libya: Ariftotle fays that it is quarrelfome, which may have been attributed to it from the analogy to the quail; but he adds, that the crex feeks to deftroy the nefts of the blackbird, which cannot apply to the rail, fince it never inhabits the woods. Still lefs is the crex of Herodotus a rail, for he compares its fize to that of the ibis, which is ten times larger. The avofet, too, and the teal, have fometimes the cry *crex, crex:* and the bird which Belon heard repeating that cry on the banks of the Nile is, according to his account, a fpecies of godwit. Thus the found reprefented by the word *crex*, belonging to feveral fpecies, is not fufficiently precife to diftinguifh the land-rail.

They are in greateft plenty in Anglefea, where they appear about the 20th of April, fuppofed to pafs over from Ireland, where they abound: at their firft arrival it is common to fhoot feven or eight in a morning. They are found in moft of the Hebrides, and the Orkneys. On their arrival they are very lean, weighing only fix ounces; but before they leave this ifland, grow fo fat as to weigh above eight. The feathers on the crown of the head and hind-part of the neck are black, edged with bay colour: the coverts of the wings of the fame colour, but not fpotted; the tail is fhort, and of a deep bay: the belly white; the legs afh-coloured.

RALPH (James), a late ingenious hiftorical and political writer, was born, we know not when or where, being firft known as a fchoolmafter in Philadelphia in North America. He came to England about the beginning of the reign of George I. and wrote fome things in the dramatic way, which were not received with great applaufe: but though he did not fucceed as a poet, he was a very ingenious profe-writer. He wrote A Hiftory of England, commencing with the Stuarts, which is much efteemed; as were his political effays and pamphlets, fome of which were looked upon as mafter-pieces. His laft publication, The Cafe of Authors by Profeffion, is an excellent and entertaining performance. He died in 1762.

RAM, in zoology. See OVIS.

Battering RAM, in antiquity, a military engine ufed to

(A) 'I tried (fays M. de Querhoent) to raife fome: they thrived wonderfully at firft, but after a fortnight's confinement their long legs grew paralytic, and the birds could only crawl on their knees; at laft they expired.' Gefner fays, that having long fed one, he found it to be peevifh and quarrelfome."

to batter down the walls of besieged places. See *Battering Ram*.

Ram's Head, in a ship, is a great block belonging to the fore and main haulyards. It has three shives in it, in which the haulyards are put; and in a hole at the end are reeved the ties.

RAMADAN, a solemn season of fasting among the Mahometans. See MAHOMETANISM.

RAMAH (anc. geog.), a town of Benjamin, near Gibea, (Judges); called *Rama of Saul* (1 Sam. xxii.), six miles from Jerusalem to the north; memorable for the story of the Levite and his concubine: Taken and fortified by Baasa king of Israel, in order to annoy the kingdom of Judah. This Rama is mentioned Isa. x. Jer. xxxi. and Matth. ii. and is to be distinguished from *Rama of Samuel*, 1 Sam. xix. called also *Ramatha*, 1 Sam. i. 19. and *Ramathaim Zophim*, ibid. i. 1. which lay a great way to the west, towards Joppa, near Lydda, 1 Maccab. ii. the birth-place of Samuel; adjoining to the mountains of Ephraim, and the place of his residence, 1 Sam. xv. &c. (Josephus). Called *Ramula* in the lower age, (Gul. Tyrius.) There is here a convent of the Fathers of the Holy Land, inhabited only by Portuguese, Spaniards, and Italians.

RAMATH-MIZPE, (Joshua xiii.); *Ramoth-Maspha*, (Septuagint, Vulgate); *Ramoth in Gilead*, or *Remmath Galaad*, (Seventy); a town in that tract of Gilead called *Maspha*, or *Mizpe*, one of the cities of refuge.

RAMAZZINI (Bernardin), an Italian physician, born at Carpi near Modena in 1633. He was professor of physic in the university of Modena for 18 years; and in 1700 accepted an invitation from Padua, where he was made rector of the college; and died in 1714. His works were collected and published in London, 1716; of which, his treatise *De Morbis Artificum*, "Of the peculiar maladies of artificers," will always be esteemed useful and curious.

RAMEKINS, a fortress of the United Netherlands, on the south coast of the island of Walchevin, in the province of Zeland. One of the cautionary towns given to Queen Elizabeth for the repayment of the charges she had been at for the defence of this republic in its infancy. Four miles east of Flushing; in N. Lat. 51. 34. E. Long. 4. 24.

RAMESES, (anc. geog.); a town built by the Israelites during their bondage in Egypt, and from which the Exodus took place, and which must have been towards and not far from the Arabian Gulph, seeing in the third station the Israelites arrived on its shore.

RAMESES, king of the Lower Egypt when Jacob went thither with his family, in the 1706th year before the Christian era. Ancient authors mention several other kings of Egypt of the same name; and it is thought that one of those princes erected in the temple of the sun at Thebes, the magnificent obelisk which the emperor Constantine caused to be removed to Alexandria in the year 334; and that prince dying, his son Constantius had the obelisk transported from Alexandria to Rome in 352, where it was erected in the grand Circus. Its height was 132 feet. When the Goths sacked the city of Rome in 409, they overthrew this obelisk, which continued buried in the sand till the time of Sixtus V. in 1587, when it was found broken in three pieces; which being joined together, it was set up in the square of St John de Lateran. On the four sides of this wonderful obelisk are a number of figures and hieroglyphical characters, which, according to the explication of Ammianus Marcellinus, contain the praises of Rameses.

RAMIFICATION, the production of boughs or branches, or of figures resembling branches.

RAMILLIES, a small village of Brabant, in the Austrian Low Countries, 12 miles north of Namur, and 22 south-east of Brussels. Lat. 50. 51. Long. 4. 48. Famous for the battle fought by the allies commanded by the duke of Marlborough and M. D'Auverquirque, against that of the two crowns, commanded by the Duke of Bavaria and Marshal Villeroy, the 22d of May 1706. See BRITAIN, n° 357.

The troops destined to compose the army of the allies being joined at the camp of Borchloon the 20th of May, halted the 21st. On the 22d the army marched from Borchloon in four columns, and posted itself the same day, with the right towards the Mill of Quorem, extending with the left towards Blehen: from this camp was discovered the army of the two crowns, which was encamped with the left at Over-Espen, and the right towards the wood of Chapiaraux, Heylissem in their front, and Tirlemont in their rear. It was resolved the same day to march the next morning towards the plain of Meerdorp or Mierdau, to view the posture of the enemies, and determine what would be the most proper means of attacking them according to the movement they should make. To this end, an advanced guard of 600 horse and all the quarter-masters of the army were sent forward on the 23d at break of day.

The same morning about four, the army marched in eight columns towards the aforesaid plain. The advanced guard and the quarter-masters arrived about eight at the height of Meerdorp or Mierdau; from whence the army of the enemy was seen in motion: a little after it was perceived that the enemy was marching through the plain of Mount St Andrew in four columns, of which information was given to the duke of Marlborough and M. D'Auverquirque, who immediately repaired to the said height; and by the time these generals were arrived there, the head of the enemy's army already appeared at the tomb of Ottomont upon the causeway, near the Mehaigne: whereupon the Duke of Marlborough and M. D'Auverquirque made the army advance with all expedition.

The enemy, as fast as they advanced, ranged in order of battle, with their right towards the tomb of Ottomont upon the Mehaigne, extending with their left to Autr'Eglise; having Tranquiers in front of their right, into which they had thrown several battalions of infantry and 14 squadrons of dragoons, who had dismounted their horses to support them. They had placed many of their infantry and a considerable part of their artillery in the village of Ramillies, which fronted the right of their main body, as well as into the village of Offuz, which fronted the left of their infantry, and into the village of Autr'Eglise, quite on their left. The front between the village of Ramillies and Autr'Eglise was covered by a small stream of water, which rendered the meadows in some places marshes, and also by several roads covered with hedges; which difficulties prevented our cavalry of the right wing from coming to action. As fast as the army of the allies arrived it was ranged in order of battle; with the left towards

Bonnef,

Bonnef, and the right towards Folz, and every thing was disposed in order to attack. To this end, four battalions were detached to attack the village of Franquenies, and twelve battalions to attack the village of Ramillies, which were to be supported by the whole infantry.

Our artillery began to cannonade the enemy at one; at about two, the attack began with the post of Franquenies, where our infantry had the good fortune to drive the enemy from the hedges, where they were advantageously posted, and at the same time all the cavalry of our left wing advanced to attack that of the enemy's right; soon after all was in action. Whilst the cavalry were engaged, the village of Ramillies was likewise attacked, and forced after a vigorous resistance.

The battle lasted about two hours, and was pretty obstinate; but so soon as our cavalry had gained ground enough to attack the enemy in flank, they began to give way; at the same time all their infantry were put in disorder, so that the whole retreated in great confusion. The cavalry of their left wing formed a little upon the high ground, between Offuz and Mount St Andrew, to favour their retreat: but after the infantry and cavalry of our right wing had filed off between the bottom of the village of Ramillies and Offuz, the whole army marched in several columns to attack the enemy anew; but they gave way before we could come up with them, and retired in great confusion, some towards the defile of the Abbey De La Ramée and towards Dongelberge, others towards Judogne, and others again towards Hougarde. They were pursued all night so closely that they were obliged to abandon all their artillery and baggage, part of which was found at Judogne and at Hougarde, with their chests of ammunition.

The enemy lost above 30,000 men, 60 cannon, 8 mortars, standards, colours, baggage, &c.; we about 3000. The rest of the campaign was spent in the sieges of Ostend, Menin, and Aeth. In fourteen days the Duke defeated and dispersed the best appointed army the French ever had, and recovered all Spanish Brabant, the marquisate of the holy Roman empire. The army of the enemy consisted of 76 battalions and 142 squadrons, including the king's houshold troops *(La Maison du Roi)*; and the army of the allies was 74 battalions and 123 squadrons. Considering the importance of the victory, the loss of the allies was very small, not above 1100 being killed, and 2600 wounded.

RAMLA, the modern name of Arimathea. See Arimathea.

RAMMER, an instrument used for driving down stones or piles into the ground; or for beating the earth, in order to render it more solid for a foundation.

Rammer of a Gun, the *Gun-stick*; a rod used in charging of a gun, to drive home the powder, as also the shot, and the wad which keeps the shot from rolling out.

RAMPANT, in heraldry, a term applied to a lion, leopard, or other beast that stands on its hind legs, and rears up his fore-feet in the posture of climbing, showing only half his face, as one eye, &c. It is different from saliant, in which the beast seems springing forward as if making a sally.

RAMPART, in fortification, is an elevation of earth round a place capable of resisting the cannon of an enemy; and formed into bastions, curtins, &c.

RAMPHASTOS, the Toucan, in ornithology. See Rhamphastos.

RAMSAY (Allan), the Scots pastoral poet, was a barber in Edinburgh in the early part of the present century. His taste in poetry, however, has justly raised him to a degree of fame that may in some measure be considered as a recompense for the frowns of fortune. His songs are in universal esteem; as is also the only dramatic performance attributed to him, viz. *Patie and Roger*, or *The Gentle Shepherd*, a Scots pastoral. He died in 1743; and was father to the ingenious Mr Ramsay, a celebrated painter of the present age, and who has likewise distinguished himself by some well-written tracts on various branches of polite literature, particularly the *Investigator*.

Ramsay (Andrew Michael), generally known by the name of the *Chevalier Ramsay*, was a polite Scots writer, born of a good family at Ayr in 1686. His good parts and learning recommended him to be tutor to the son of the earl of Wemyss; after which, conceiving a disgust at the religion in which he had been educated, he in the same ill humour reviewed other Christian churches; and, finding none to his liking, rested for a while in Deism. While he was in this uncertain state of mind, he went to Leyden; where, falling into the company of one Poiret a mystic divine, he received the infection of mysticism: which prompted him to consult M. Fenelon, the celebrated archbishop of Cambray, who had imbibed principles of the same nature; and who gained him over to the Catholic religion in 1709. The subsequent course of his life received its direction from his friendship and connections with this prelate; and being appointed governor to the duke de Chateau Thierry, and the prince de Turenne, he was made a knight of the order of St Lazarus. He was sent for to Rome by the chevalier de St George, to undertake the education of his children; but he found so many intrigues and dissensions on his arrival there in 1724, that he obtained the Chevalier's leave to return to Paris. He died in 1743, in the office of intendant to the duke of Bouillon, prince de Turenne. The most capital work of his writing is the *Travels of Cyrus*, which has been several times printed in English.

Ramsay (the Reverend James), so justly celebrated for his philanthropy, was, on the 25th of July 1733, born at Frasersburgh, a small town in the county of Aberdeen, North Britain. His descent was honourable, being, through his father, from the Ramsays of Melrose in Banffshire, and through his mother, from the Ogilvies of Purie in Angus. His parents were of characters the most respectable, but in circumstances by no means affluent. From his earliest years he discovered a serious disposition, and a strong thirst for knowledge; and after passing through the course of a Scotch grammar school education, he was inclined to pursue the studies requisite to fit him for the profession of a clergyman; an inclination with which the wishes of his mother, a woman of eminent piety, powerfully concurred. Several circumstances, however, conspired to divert him for a time from his favourite pursuit.

He was educated in the episcopal persuasion; and having been unhappy enough to lose his father while yet very young, he found, upon his advancing towards the state of manhood, that the joint fortunes of himself and

Ramfay.

his mother could not bear the expence of a regular education in either of the univerfities of Oxford or Cambridge, which he doubtlefs thought abfolutely neceffary to one who afpired to refpectability in the church of England. Yielding therefore to neceffity, he refolved to ftudy furgery and pharmacy; and was with this view bound apprentice to Dr Findlay, a phyfician (A) in Frafersburgh. But though obliged to relinquifh for a time his favourite ftudies, he did not think ignorance excufable in a furgeon more than in a clergyman, or conceive that he could ever become eminent in the profeffion in which circumftances had placed him, merely by fkill in fetting a bone or compounding a medicine. He determined therefore, with the full approbation of his mafter, who very foon difcovered his talents for literature, to make himfelf acquainted with at leaft the outlines of the liberal arts and fciences; and with this view he repaired in 1750 to the King's College and univerfity of Aberdeen, where he obtained one of the *burfaries* or *exhibitions* which are there annually beftowed upon fuch candidates for them as difplay the moft accurate knowledge of the Latin language. The fmall fum of five pounds, however (which none of thefe burfaries exceed), was ftill inadequate to the expence of refidence in college; but our young ftudent was foon to obtain a more valuable exhibition, and to obtain it likewife by his own merit.

During the long vacation he returned to his mafter Dr Findlay, and was by him intrufted with a very defperate cafe in furgery, of which his management may be faid to have laid the foundation of his future fortunes. A female fervant of one of the judges of the Court of Seffion, who, when the court was not fitting, refided in the neighbourhood of Fraferfburgh, had been fo dreadfully gored by a bull, that hardly any hopes were entertained of her recovery; but Mr Ramfay, to whofe care fhe was entirely left, treated the wound with fuch fkilful attention, that, contrary to general expectation, his patient recovered. This attracted the judge's notice, who having informed himfelf of the young man's circumftances and character, recommended him fo effectually to Sir Alexander Ramfay of Balmain, that he prefented him with a burfary of 15 pounds a-year, which commenced at the next *feffion* or *term*, in the fame college.

He now profecuted his ftudies with comfort; and though he was detained in college a year longer than is ufual, being obliged, upon his acceptance of a fecond burfary, to begin his courfe anew, he always confidered this as a fortunate circumftance, becaufe it gave him the celebrated Dr Reid three years for his preceptor. To that great and amiable philofopher he fo recommended himfelf by his talents, his induftry, and his virtues, that he was honoured with his friendfhip to the day of his death. Nor was it only to his mafters that his conduct recommended him; Sir Alexander Ramfay, whom he vifited during fome of the vacations, was fo well pleafed with his converfation, that he promifed him another burfary, in his gift, of 25l. a-year, to commence immediately on the expiration of that which he enjoyed. This promife he performed in the beginning of the year 1755; and at the folicitation of Dr Findlay even paid the money per advance to enable the exhibitioner to travel for the purpofe of improving himfelf in his profeffion.

Ramfay.

Thus provided, Mr Ramfay went to London, and ftudied furgery and pharmacy under the aufpices of Dr Macauly; in whofe family he lived for two years, careffed and efteemed both by him and by his lady. Afterwards, having paffed the ufual examination at Surgeon's-hall, he ferved in his medical capacity for feveral years in the royal navy; but how long he was continued in the ftation of a mate, or when and by whom he was firft appointed furgeon, we have not been able to learn. We can fay, however, upon the beft authority, that by his humane and diligent difcharge of his duty in either ftation, he endeared himfelf to the feamen, and acquired the efteem of his officers.

Of his humanity there is indeed one memorable inftance, which muft not be omitted. Whilft he acted as furgeon of the Arundel, then commanded by Captain (now Vice-admiral Sir Charles) Middleton, a flave-fhip on her paffage from Africa to the Weft Indies fell in with the fleet to which the Arundel belonged. An epidemical diftemper, too common in fuch veffels, had fwept away not only a great number of the unfortunate negroes, but alfo many of the fhip's crew, and among others the furgeon. In this diftreffed fituation the commander of the Guinea fhip applied to the Englifh Commodore for medical affiftance; but not a furgeon or furgeon's mate in the whole fleet, except Mr Ramfay, would expofe himfelf to the contagion of fo dangerous a diftemper. Prompted, however, by his own innate benevolence, and fully authorized by his no lefs benevolent commander, the furgeon of the Arundel, regardlefs of perfonal danger, and trufting in that God to whom mercy is more acceptable than facrifice, went on board the infected fhip, vifited all the patients, and remained long enough to leave behind him written directions for their future treatment. If a cup of cold water given in charity be entitled to a reward, how much more fuch an action as this? But the rewards of Chriftianity are not immediate. Mr Ramfay indeed efcaped the contagion; but on his return to his own fhip, juft as he had got on the deck, he fell and broke his thigh-bone; by which he was confined to his apartment for ten months, and rendered in a fmall degree lame through the remainder of his life.

The fearlefs humanity which he difplayed on this occafion gained him the friendfhip and efteem of Sir Charles Middleton, which no future action of his life had the fmalleft tendency to impair; but the fracture of his thigh-bone and his fubfequent lamenefs determined him to quit the navy, and once more turn his thoughts towards the church. Accordingly, while the Arundel lay at St Chriftopher's, he opened his views to fome

(A) In the remote towns of Scotland the fame man generally acts in the triple capacity of phyfician, furgeon, and apothecary; and we could mention doctors of phyfic of the firft eminence, who practife thus within forty miles of Edinburgh.

Ramfay.

fome of the principal inhabitants of that ifland, by whom he was fo ftrongly recommended to the bifhop of London, that on his coming home with Sir Charles Middleton, who warmly joined in the recommendation, he was admitted into orders; after which he immediately returned to St Chriftopher's, where he was prefented by the governor to two rectories, valued at 700l. a-year.

As foon as he took poffeffion of his livings, in 1763, he married Mifs Rebecca Akers, the daughter of a planter of the beft family-connections in the ifland, and began to regulate his houfehold on the pious plan inculcated in his *Effay on the Treatment and Converfion of the African Slaves in the Britifh Sugar Colonies.* He fummoned all his own flaves daily to the prayers of the family, when he took an opportunity of pointing out to them their duty in the plaineft terms, reproving thofe that had done amifs, and commending fuch as had fhown any thing like virtue; but he confeffed that his occafions for reproof were more frequent than for commendation. As became his office and character, he inculcated upon others what he practifed himfelf, and knew to be equally the duty of all. "On his firft fettlement as a minifter in the Weft Indies, he made fome public attempts to inftruct flaves. He began to draw up fome eafy, plain difcourfes for their inftruction. He invited them to attend on Sundays, at particular hours. He appointed hours at home to inftruct fuch fenfible flaves as would of themfelves attend. He repeatedly exhorted their mafters to encourage fuch in their attendance. He recommended the French cuftom, of beginning and ending work by prayer. But inconceivable is the liftleffnefs with which he was heard, and bitter was the cenfure heaped on him in return. It was quickly fuggefted, and generally believed, that he wanted to interrupt the work of flaves, to give them time, forfooth, to fay their prayers; that he aimed at the making of them Chriftians, to render them incapable of being good flaves. In one word, he ftood, in opinion, a rebel convict againft the intereft and majefty of plantérfhip. And as the Jews fay, that in every punifhment, with which they have been proved, fince the bondage of Egypt, there has been an ounce of the golden calf of Horeb; fo might he fay, that in every inftance of prejudice (and they were not a few) with which, till within a year or two of his departure from the country, he was exercifed, there was an ounce of his fruitlefs attempts to improve the minds of flaves. In the bidding prayer, he had inferted a petition for the converfion of thofe perfons. But it was deemed fo difagreeable a memento, that feveral white people, on account of it, left off attending divine fervice. He was obliged to omit the prayer entirely, to try and bring them back. In fhort, neither were the flaves, at that time, defirous of being taught, nor were their mafters inclined to encourage them."

That he was hurt by this neglect cannot be queftioned, for he had a mind benevolent, warm, and irritable; but he ftill retained many friends amongft the moft worthy members of the community: and as he was confcious of having done nothing more than his duty, he confoled himfelf with reflecting, that thofe are "bleffed whom men revile, and perfecute, and fpeak all manner of evil againft falfely, for the fake of the gofpel."

Although his ferious ftudies were now theological, he confidered himfelf as anfwerable to God, his country, and his own family, for a proper ufe of every branch of knowledge which he poffeffed. He therefore took the charge of fever al plantations around him in the capacity of a medical practitioner; and attended them with unremitting diligence, and with great fuccefs. Thus he lived till the year 1777, when relinquifhing the practice of phyfic entirely, he paid a vifit to the place of his nativity, which he had not feen fince 1755. His mother, whofe latter days he had made comfortable by a handfome annuity, had been dead for fome years; but he rewarded all who had been attentive to her, or in early life ferviceable to himfelf; and he continued the penfion to a fifter who had a numerous family, for which her hufband was unable to provide.

After remaining three weeks in Scotland, and near a year in England, during which time he was admitted into the confidence of Lord George Germaine, fecretary of ftate for the American department, Mr Ramfay was appointed chaplain to Admiral Barrington, then going out to take a command in the Weft Indies. Under this gallant officer, and afterwards under Lord Rodney, he was prefent at feveral engagements, where he difplayed a fortitude and zeal for the honour of his country which would not have difgraced the oldeft admiral. To the navy, indeed, he feems to have been ftrongly attached; and he wrote, at an early period of his life, an *Effay on the Duty and Qualifications of a Sea-officer,* with fuch a knowledge of the fervice as would have done honour to the pen of the moft experienced commander. Of the firft edition of this effay the profits were by its benevolent author appropriated to the Magdalen and Britifh lying-in hofpitals, as thofe of the fecond and third (which laft was publifhed about the period of which we now write) were to the maritime fchool, or, in the event of its failure, to the marine fociety.

Although careffed by both the admirals under whom he ferved, and having fuch influence with the latter as to be able to render effential fervices to the Jews and other perfons whom he thought harfhly treated at the capture of St Euftatius, Mr Ramfay once more quitted the fea-fervice, and retired to his paftoral charge in the Ifland of St Chriftopher's. There, however, though the former animofities againft him had entirely fubfided, and though his friendfhip was now folicited by every perfon of confequence in the ifland, he remained but a little while. Sick of the life of a planter and of the profpect of flavery around him, he refigned his livings, bade adieu to the ifland, and returned to England with his wife and family in the end of the year 1781. Immediately on his arrival, he was, through the intereft of his fteady friend Sir Charles Middleton, prefented to the livings of Tefton and Nettleftead in the county of Kent.

Here he was foon determined, by the advice of thofe whom he moft refpected, to publifh an *Effay,* which had been written many years before, *on the Treatment and Converfion of African Slaves in the Britifh Sugar Colonies.* The controverfy in which this publication involved him, and the acrimony with which it was carried on, are fo frefh in the memory of all our readers, that no man who thinks of the narrow limits within which our biographical articles muft be confined, will blame us for not entering into a detail of the particulars.—Torrents of obloquy were poured upon the benevolent author by writers who were unfair enough to conceal their

Ramfay. Ramfden's Machine.

their names; and it muft be confeffed, that his replies abounded with farcafms, which the moft rational friends to the caufe which he fupported would not have been forry to fee blotted from his pages. The provocation, however, which he received was great; and Mr Ramfay, though an amiable, virtuous, and pious man, had a warmth of temper, which, though not deferving of praife, will be cenfured by none who reflect on the frailties of our common nature. That the particular calumnies propagated againft him on this occafion were wholly groundlefs, it is impoffible to doubt, if we admit him to have been poffeffed of common underftanding. When fome years ago a ftory was circulated, of Swift's having, when prebendary of Kilroot, been convicted before a magiftrate of an attempt to commit a rape on the body of one of his parifhioners, it was thought a fufficient confutation of the calumny to put the retailer of it in mind, that the dean of St Patrick's, though detefted by the moft powerful faction in the kingdom, lampooned without dread, and with great feverity, the dean of Ferns for the very crime of which, had this anecdote been true, he muft have been confcious that all Ireland knew himfelf to be guilty! Such conduct cannot be reconciled to common fenfe. Had Swift been a ravifher, though he might have been penitent, and reafoned in general terms againft giving way to fuch licentious paffions, he would never have fatyrifed a *particular perfon* for the crime of which he himfelf ftood convicted. In like manner, had Mr Ramfay been a tyrant to his own flaves, though he might have argued againft flavery in the abftract, on the broad bafis of virtue and religion, he never could have arraigned for fimilar cruelty a number of individuals in the very ifland which witneffed his own enormities.

But the melancholy part of the narrative is behind. The agitation given to his mind by thefe calumnies, and the fatigues he underwent in his endeavours to refcue from mifery the moft helplefs portion of the human race, contributed to fhorten a life in no common degree ufeful. He had been for fome time afflicted with a pain in his ftomach, for which he was prevailed upon, tho' with great reluctance, to try the effects of air and exercife, by attempting a journey of 100 miles. But in London, being feized with a violent vomiting of blood, he was unable either to proceed or to be removed home; and in the houfe of Sir Charles Middleton he ended his days, on the 20th of July 1789, amidft the groans of his family, and the tears of many friends.—Thus died a man, of whom it is not too much to fay, that "the bleffing of many that were ready to perifh came upon him;" for whatever be the fate of the flave-trade (fee SLAVERY), it is certain that his writings have contributed much to meliorate the treatment of flaves. He left behind him a widow and three daughters: and his works, befides thofe to which we have alluded, confift of a volume of *Sea-fermons*, preached on board his majefty's fhip the Prince of Wales, which fhow him to have been a mafter of true pulpit-eloquence; and a *Treatfe on Signals*, which was certainly written, and we think printed, though we know not whether it was ever publifhed.

RAMSDEN's MACHINE *for Dividing* MATHEMATICAL INSTRUMENTS, is a late invention, by which thefe divifions can be performed with exceeding great accuracy, fuch as would formerly have been deemed incredible. On difcovering the method of conftructing this machine, its inventor, Mr Ramfden of Piccadilly, received 615 l. from the commiffioners of longitude; engaging himfelf to inftruct a certain number of perfons, not exceeding ten, in the method of making and ufing this machine from the 28th October 1775 to 28th October 1777: alfo binding himfelf to divide all octants and fextants by the fame engine, at the rate of three fhillings for each octant, and fix fhillings for each brafs fextant, with Nonius's divifions to half minutes, for as long time as the commiffioners fhould think proper to let the engine remain in his poffeffion. Of this fum of 615 l. paid to Mr Ramfden, 300 l. was given him as a reward for the improvement made by him in difcovering the engine, and the remaining 315 l. for his giving up the property of it to the commiffioners. The following defcription of the engine, is that given upon oath by Mr Ramfden himfelf.

"This engine confifts of a large wheel of bell-metal, fupported on a mahogany ftand, having three legs, which are ftrongly connected together by braces, fo as to make it perfectly fteady. On each leg of the ftand is placed a conical friction-pulley, whereon the dividing-wheel refts: to prevent the wheel from fliding off the friction-pulleys, the bell-metal centre under it turns in a focket on the top of the ftand.

"The circumference of the wheel is ratched or cut (by a method which will be defcribed hereafter) into 2160 teeth, in which an endlefs fcrew acts. Six revolutions of the fcrew will move the wheel a fpace equal to one degree.

"Now a circle of brafs being fixed on the fcrew arbor, having its circumference divided into 60 parts, each divifion will confequently anfwer to a motion of the wheel of 10 feconds, fix of them will be equal to a minute, &c.

"Several different arbors of tempered fteel are truly ground into the focket in the centre of the wheel. The upper parts of the arbors that ftand above the plane are turned of various fizes, to fuit the centres of different pieces of work to be divided.

"When any inftrument is to be divided, the centre of it is very exactly fitted on one of thefe arbors; and the inftrument is fixed down to the plane of the dividing wheel, by means of fcrews, which fit into holes made in the radii of the wheel for that purpofe.

"The inftrument being thus fitted on the plane of the wheel, the frame which carries the dividing-point is connected at one end by finger-fcrews with the frame which carries the endlefs fcrew; while the other end embraces that part of the fteel arbor, which ftands above the inftrument to be divided, by an angular notch in a piece of hardened fteel; by this means both ends of the frame are kept perfectly fteady and free from any fhake.

"The frame carrying the dividing-point or tracer, is made to flide on the frame which carries the endlefs fcrew to any diftance from the centre of the wheel as the radius of the inftrument to be divided may require, and may be there faftened by tightening two clamps; and the dividing-point or tracer being connected with the clamps by the double-jointed frame, admits a free and eafy motion towards or from the centre for cutting the divifions, without any lateral fhake.

"From what has been faid, it appears, that an in-

mſden's Machine. ſtrument thus fitted on the dividing-wheel may be moved to any angle by the ſcrew and divided circle on its arbor, and that this angle may be marked on the limb of the inſtrument with the greateſt exactneſs by the dividing-point or tracer, which can only move in a direct line tending to the centre, and is altogether freed from thoſe inconveniences that attend cutting by means of a ſtraight edge. This method of drawing lines will alſo prevent any error that might ariſe from an expanſion or contraction of the metal during the time of dividing.

"The ſcrew-frame is fixed on the top of a conical pillar, which turns freely round its axis, and alſo moves freely towards or from the centre of the wheel, ſo that the ſcrew-frame may be entirely guided by the frame which connects it with the centre: by this means any excentricity of the wheel and the arbor would not produce any error in the dividing; and, by a particular contrivance (which will be deſcribed hereafter), the ſcrew when preſſed againſt the teeth of the wheel always moves parallel to itſelf; ſo that a line joining the centre of the arbor and the tracer continued, will always make equal angles with the ſcrew.

Plate CCCCXXXIII "Figure 1. repreſents a perſpective view of the engine.

Plate CCCCXXXIV "Fig. 2. is a plan, of which fig. 3. repreſents a ſection on the line IIA.

"The large wheel A is 45 inches in diameter, and has ten radii, each being ſupported by edge-bars, as repreſented in fig. 3. Theſe bars and radii are connected by the circular ring B, 24 inches in diameter and 3 deep; and, for greater ſtrength, the whole is caſt in one piece in bell-metal.

"As the whole weight of the wheel A reſts on its ring B, the edge-bars are deepeſt where they join it; and from thence their depth diminiſhes, both towards the centre and the circumference, as repreſented in fig. 3.

"The ſurface of the wheel A was worked very even and flat, and its circumference turned true. The ring C, of fine braſs, was fitted very exactly on the circumference of the wheel; and was faſtened thereon with ſcrews, which, after being ſcrewed as tight as poſſible, were well rivetted. The face of a large chuck being turned very true and flat in the lath, the flattened ſur-

Fig. 3. face A of the wheel was faſtened againſt it with holdfaſts; and the two ſurfaces and circumference of the ring C, a hole through the centre and the plane part round (b) it, and the lower edge of the ring B, were turned at the ſame time.

"D is a piece of hard bell-metal, having the hole, which receives the ſteel-arbor (d), made very ſtraight and true. This bell-metal was turned very true on an arbor; and the face, which reſts on the wheel at (b), was turned very flat, ſo that the ſteel arbor (d) might ſtand perpendicular to the plane of the wheel: this bell-metal was faſtened to the wheel by ſix ſteel ſcrews (l).

"A braſs ſocket Z is faſtened on the centre of the mahogany ſtand, and receives the lower part of the bell-metal piece D, being made to touch the bell-metal in a narrow part near the mouth, to prevent any obliquity of the wheel from bending the arbor: good fitting is by no means neceſſary here; ſince any ſhake in this ſocket will produce no bad effect, as will appear Ramſden's Machine.
hereafter when we deſcribe the cutting frame.

"The wheel was then put on its ſtand, the lower Fig. 1, 2, and 3.
edge of the ring B reſting on the circumference of three conical friction-pulleys W, to facilitate its motion round its centre. The axis of one of theſe pulleys is in a line joining the centre of the wheel and the middle of the endleſs ſcrew, and the other two placed ſo as to be at equal diſtances from each other.

"F is a block of wood ſtrongly faſtened to one of the Fig. 1.
legs of the ſtand; the piece (g) is ſcrewed to the upper ſide of the block, and has half holes, in which the tranſverſe axis (h) turns: the half holes are kept toge- Fig. 4.
ther by the ſcrews (i).

"The lower extremity of the conical pillar P termi- Fig. 1. & 4.
nates in a cylindrical ſteel-pin (k), which paſſes through Fig. 4.
and turns in the tranſverſe axis (h), and is confined by a cheek and ſcrew.

"To the upper end of the conical pillar is faſtened the frame G, in which the endleſs ſcrew turns: the Fig. 4.
pivots of the ſcrew are formed in the manner of two fruſtums of cones joined by a cylinder, as repreſented at X. Theſe pivots are confined between half poles, which preſs only on the conical parts, and do Fig. 5.
not touch the cylindric parts: the half holes are kept together by ſcrews (a), which may be tightened at any time, to prevent the ſcrew from ſhaking in the frame.

"On the ſcrew-arbor is a ſmall wheel of braſs K, Fig. 1, 2, 4, 5.
having its outſide edge divided into 60 parts, and numbered at every 6th diviſion with 1, 2, &c. to 10. The motion of this wheel is ſhown by the index (y) on the Fig. 4. & 5.
ſcrew-frame G.

"H repreſents a part of the ſtand, having a parallel Fig. 1.
ſlit in the direction towards the centre of the wheel, large enough to receive the upper part of the conical braſs pillar P, which carries the ſcrew and its frame: and as the reſiſtance, when the wheel is moved by the endleſs ſcrew, is againſt that ſide of the ſlit H which is towards the left hand, that ſide of the ſlit is faced with braſs, and the pillar is preſſed againſt it by a ſteel ſpring on the oppoſite ſide: by this means the pillar is ſtrongly ſupported laterally, and yet the ſcrew may be eaſily preſſed from or againſt the circumference of the wheel, and the pillar will turn freely on its axis to take any direction given it by the frame L.

"At each corner of the piece I are ſcrews (n) of Fig. 4.
tempered ſteel, having poliſhed conical points: two of them turn in conical holes in the ſcrew-frame near (o), and the points of the other two ſcrews turn in holes in the piece Q; the ſcrews (p) are of ſteel, which being tightened, prevent the conical pointed ſcrews from unturning when the frame is moved.

"L is a braſs frame, which ſerves to connect the end- Fig. 1, 2, 6.
leſs ſcrew, its frame, &c. with the centre of the wheel: each arm of this frame is terminated by a ſteel ſcrew, that may be paſſed through any of the holes (q) in the Fig. 4.
piece Q, as the thickneſs of work to be divided on the wheel may require, and are faſtened by the finger- Fig. 1. & 2.
nuts (r).

"At the other end of this frame is a flat piece of Fig. 6.
tempered ſteel (b), wherein is an angular notch: when the endleſs ſcrew is preſſed againſt the teeth on the circumference of the wheel, which may be done by turn- Fig. 1. & 2.
ing the finger-ſcrew S, to preſs againſt the ſpring (t), this

Ramſden's Machine.

this notch embraces and preſſes againſt the ſteel arbor (d). This end of the frame may be raiſed or depreſſed by moving the priſmatic ſlide (u), which may be fixed at any height by the four ſteel-ſcrews (v). (Fig. 2. Fig. 1, 2, 6.)

"The bottom of this ſlide has a notch (k), whoſe plane is parallel to the endleſs-ſcrew; and by the point of the arbor (d) reſting in this notch, this end of the frame is prevented from tilting. The ſcrew S is prevented from unturning, by tightening the finger-nut (w). (Fig. 1. & 6. Fig. 3. Fig. 1, 2.)

"The teeth on the circumference of the wheel were cut by the following method:

"Having conſidered what number of teeth on the circumference would be moſt convenient, which in this engine is 2160, or 360 multiplied by 6, I made two ſcrews of the ſame dimenſions, of tempered ſteel, in the manner hereafter deſcribed, the interval between the threads being ſuch as I knew by calculation would come within the limits of what might be turned off the circumference of the wheel: one of theſe ſcrews, which was intended for ratching or cutting the teeth, was notched acroſs the threads, ſo that the ſcrew, when preſſed againſt the edge of the wheel and turned round, cut in the manner of a ſaw. Then having a ſegment of a circle a little greater than 60 degrees, of about the ſame radius with the wheel, and the circumference made true, from a very fine centre, I deſcribed an arch near the edge, and ſet off the chord of 60 degrees on this arch. This ſegment was put in the place of the wheel, the edge of it was ratched, and the number of revolutions and parts of the ſcrew contained between the interval of the 60 degrees were counted. The radius was corrected in the proportion of 360 revolutions, which ought to have been in 60 degrees, to the number actually found; and the radius, ſo corrected, was taken in a pair of beam-compaſſes: while the wheel was on the lath, one foot of the compaſſes was put in the centre, and with the other a circle was deſcribed on the ring; then half the depth of the threads of the ſcrew being taken in dividers, was ſet from this circle outwards, and another circle was deſcribed cutting this point; a hollow was then turned on the edge of the wheel of the ſame curvature as that of the ſcrew at the bottom of the threads: the bottom of this hollow was turned to the ſame radius or diſtance from the centre of the wheel, as the outward of the two circles before-mentioned.

"The wheel was now taken off the lath; and the bell-metal piece D was ſcrewed on as before directed, which after this ought not to be removed. (Fig. 3.)

"From a very exact centre a circle was deſcribed on the ring C, about $\frac{4}{10}$ of an inch within where the bottom of the teeth would come. This circle was divided with the greateſt exactneſs I was capable of, firſt into five parts, and each of theſe into three. Theſe parts were then biſected four times: (that is to ſay) ſuppoſing the whole circumference of the wheel to contain 2160 teeth, this being divided into five parts, each would contain 432 teeth; which being divided into three parts, each of them would contain 144; and this ſpace biſected four times would give 72, 36, 18, and 9: therefore each of the laſt diviſions would contain nine teeth. But, as I was apprehenſive ſome error might ariſe from quinqueſection and triſection, in order to examine the accuracy of the diviſions, I deſcribed another circle on the ring C, $\frac{1}{10}$ inch within the former, and divided it by continual biſections, as 2160, 1080, 540, 270, 135, 67½, and 33¾; and as the fixed wire (to be deſcribed preſently) croſſed both the circles, I could examine their agreement at every 135 revolutions; (after ratching, could examine it at every 33¾): but, not finding any ſenſible difference between the two ſets of diviſions, I, for ratching, made choice of the former; and, as the coincidence of the fixed wire with an interſection could be more exactly determined than with a dot or diviſion, I therefore made uſe of interſections in both circles before deſcribed. (Fig. 1, 2, 3. Fig. 7.)

"The arms of the frame L were connected by a thin piece of braſs of ¼ of an inch broad, having a hole in the middle of $\frac{4}{10}$ of an inch in diameter; acroſs this hole a ſilver wire was fixed exactly in a line to the centre of the wheel; the coincidence of this wire with the interſections was examined by a lens $\frac{7}{10}$ inch focus, fixed in a tube which was attached to one of the arms L (A). Now a handle or winch being fixed on the end of the ſcrew, the diviſion marked 10 on the circle K was ſet to its index, and, by means of a clamp and adjuſting ſcrew for that purpoſe, the interſection marked 1 on the circle C was ſet exactly to coincide with the fixed wire; the ſcrew was then carefully preſſed againſt the circumference of the wheel, by turning the finger-ſcrew S; then, removing the clamp, I turned the ſcrew by its handle 9 revolutions, till the interſection marked 240 came nearly to the wire; then, unturning the finger-ſcrew S, I releaſed the ſcrew from the wheel, and turned the wheel back till the interſection marked 2 exactly coincided with the wire, and, by means of the clamp before-mentioned, the diviſion 10 on the circle being ſet to its index, the ſcrew was preſſed againſt the edge of the wheel by the finger-ſcrew S; the clamps were removed, and the ſcrew turned nine revolutions till the interſection marked 1 nearly coincided with the fixed wire; the ſcrew was releaſed from the wheel by unturning the finger-ſcrew S as before, the wheel was turned back till the interſection 3 coincided with the fixed wire; the diviſion 10 on the circle being ſet to its index, the ſcrew was preſſed againſt the wheel as before, and the ſcrew was turned 9 revolutions, till the interſection 2 nearly coincided with the fixed wire, and the ſcrew was releaſed; and I proceeded in this manner till the teeth were marked round the whole circumference of the wheel. This was repeated three times round, to make the impreſſion of the ſcrew deeper. I then ratched the wheel round continually in the ſame direction without ever diſengaging the ſcrew; and, in ratching the wheel about 300 times round, the teeth were finiſhed. (Fig. 7.)

"Now it is evident, if the circumference of the wheel was even one tooth or ten minutes greater than the ſcrew would require, this error would in the firſt in-

4 ſtance

(A) The interſections are marked for the ſake of illuſtration, though properly inviſible, they lying under the braſs plate.

ſden's chine. ſtance be reduced to $\frac{1}{240}$ part of a revolution, or two ſeconds and a half; and theſe errors or inequalities of the teeth were equally diſtributed round the wheel at the diſtance of nine teeth from each other. Now, as the ſcrew in ratching had continually hold of ſeveral teeth at the ſame time, and, theſe conſtantly changing, the above-mentioned inequalities ſoon corrected themſelves, and the teeth were reduced to a perfect equality. The piece of braſs which carries the wire was now taken away, and the cutting ſcrew was alſo removed, and a plain one (hereafter deſcribed) put in its place: on one end of the ſcrew is a ſmall braſs circle, having its edge divided into 60 equal parts, and numbered at every ſixth diviſion, as before-mentioned. On the other end of the ſcrew is a ratchet-wheel C, having 60 teeth,
5. covered by the hollowed circle (d), which carries two clicks that catch upon the oppoſite ſides of the ratchet when the ſcrew is to be moved forwards. The cylinder S turns on a ſtrong ſteel arbor F, which paſſes through and is firmly ſcrewed to the piece Y: this piece, for greater firmneſs, is attached to the ſcrew-
4. frame G by the braces (v): a ſpiral groove or thread is cut on the outſide of the cylinder S, which ſerves both for holding the ſtring, and alſo giving motion to the lever J on its centre by means of a ſteel tooth (n), that works between the threads of the ſpiral. To the lever is attached a ſtrong ſteel pin (m), on which a braſs ſocket (r) turns: this ſocket paſſes through a ſlit in the piece (p), and may be tightened in any part of the ſlit by the finger-nut (f): this piece ſerves to regulate the number of revolutions of the ſcrew for each tread of the treadle R.

1. "T is a braſs box containing a ſpiral ſpring; a
1. ſtrong gut is faſtened and turned three or four times round the circumference of this box; the gut then paſſes ſeveral times round the cylinder S, and from thence down to the treadle R. Now, when the treadle is preſſed down, the ſtring pulls the cylinder S round its axis, and the clicks catching hold of the teeth on the ratchet carry the ſcrew round with it, till, by the tooth (n) working in the ſpiral groove, the lever J is
4. brought near the wheel (d), and the cylinder ſtopped by the ſcrew-head (x) ſtriking on the top of the lever J; at the ſame time the ſpring is wound up by the other end of the gut paſſing round the box T. Now,
1. when the foot is taken off the treadle, the ſpring unbending itſelf pulls back the cylinder, the clicks leaving the ratchet and ſcrew at reſt till the piece (t) ſtrikes on the end of the piece (p): the number of revolutions
1. of the ſcrew at each tread is limited by the number of revolutions the cylinder is allowed to turn back before the ſtop ſtrikes on the piece (p).

"When the endleſs ſcrew was moved round its axis with a conſiderable velocity, it would continue that motion a little after the cylinder S was ſtopped: to
1. & 4. prevent this, the angular lever π was made; that when the lever J comes near to ſtop the ſcrew (x), it, by a ſmall chamfer, preſſes down the piece × of the angular lever; this brings the other end ψ of the ſame lever forwards, and ſtops the endleſs ſcrew by the ſteel pin μ ſtriking upon the top of it: the foot of the lever is raiſed again by a ſmall ſpring preſſing on the brace (v).

1, 2, 6. "D, two clamps, connected by the piece α, ſlide one on each arm of the frame L, and may be fixed at pleaſure by the four finger-ſcrews ε, which preſs againſt ſteel ſprings to avoid ſpoiling the arms: the piece (q) is made to turn without ſhake between two conical pointed ſcrews (f), which are prevented from unturning by tightening the finger-nuts N.

Ramſden's Machine.

"The piece M is made to turn on the piece (q), by the conical pointed ſcrews (f) reſting in the hollow centers (e). Fig. 6.

"As there is frequent occaſion to cut diviſions on inclined planes, for that purpoſe the piece γ, in which the tracer is fixed, has a conical axis at each end, which turn in half holes: when the tracer is ſet to any inclination, it may be fixed there by tightening the ſteel ſcrews δ.

Deſcription of the Engine by which the endleſs ſcrew of the Dividing Engine was cut.

"Fig. 9. repreſents this engine of its full dimenſions ſeen from one ſide.

"Fig. 8. the upper ſide of the ſame as ſeen from above.

"A repreſents a triangular bar of ſteel, to which the triangular holes in the pieces B and C are accurately fitted, and may be fixed on any part of the bar by the ſcrews D.

"E is a piece of ſteel whereon the ſcrew is intended to be cut; which, after being hardened and tempered, has its pivots turned in the form of two fruſtums of cones, as repreſented in the drawings of the dividing engine (fig. 5.). Theſe pivots were exactly fitted to the half holes F and T, which were kept together by the ſcrews Z.

"H repreſents a ſcrew of untempered ſteel, having a pivot I, which turns in the hole K. At the other end of the ſcrew is a hollow centre, which receives the hardened conical point of the ſteel pin M. When this point is ſufficiently preſſed againſt the ſcrew, to prevent its ſhaking, the ſteel pin may be fixed by tightening the ſcrews Y.

"N is a cylindric nut, moveable on the ſcrew H; which, to prevent any ſhake, may be tightened by the ſcrews O. This nut is connected with the ſaddle-piece P by means of the intermediate univerſal joint W, through which the arbor of the ſcrew H paſſes. A front view of this piece, with a ſection acroſs the ſcrew-arbor, is repreſented at X. This joint is connected with the nut by means of two ſteel ſlips S, which turn on pins between the cheeks T on the nut N. The other ends of theſe ſlips S turn in like manner on pins (a). One axis of this joint turns in a hole in the cock (b), which is fixed to the ſaddle-piece; and the other turns in a hole (d), made for that purpoſe in the ſame piece on which the cock (b) is fixed. By this means, when the ſcrew is turned round, the ſaddle-piece will ſlide uniformly along the triangular bar A.

"K is a ſmall triangular bar of well-tempered ſteel, which ſlides in a groove of the ſame form on the ſaddle-piece P. The point of this bar or cutter is formed to the ſhape of the thread intended to be cut on the endleſs ſcrew. When the cutter is ſet to take proper hold of the intended ſcrew, it may be fixed by tightening the ſcrew (e), which preſs the two pieces of braſs G upon it.

"Having meaſured the circumference of the dividing-wheel, I found it would require a ſcrew about one thread

thread in a hundred coarser than the guide-screw H. The wheels on the guide-screw arbor H, and that on the steel E, on which the screw was to be cut, were proportioned to each other to produce that effect, by giving the wheel L 198 teeth, and the wheel Q 200. These wheels communicated with each other by means of the intermediate wheel R, which also served to give the threads on the two screws the same direction.

"The saddle-piece P is confined on the bar A by means of the pieces (g), and may be made to slide with a proper degree of tightness by the screws (n)."

For Ramsden's equatorial or portable observatory, see OPTICS, n° 102. and ASTRONOMY, n° 504. See also a long account of an equatorial instrument made by Mr Ramsden by the direction of Sir George Shuckburgh in the Philosophical Transactions for 1793, art. x. p. 67. In this instrument the circle of declinations is four feet in diameter, and may be observed nearly to a second. The glass is placed between six pillars, which form the axis of the machine, and turn round by two pivots placed on two blocks of stone. See also BAROMETER.

RAMSEY, a town of Huntingdonshire, 68 miles north of London, and 12 north-east of Huntingdon. It is situated as it were in an island, being everywhere encompassed with fens, except on the west, where it is separated from the *terra firma* by a causey for two miles. The neighbouring meers of Ramsey and Whittlesey, which are formed by the river Nyne, abound with fowl and fish, especially eel and large pikes. It was once famous for a very rich abbey, part of the gatehouse of which is still standing, and a neglected statue of Ailwin; the epitaph of whose tomb, which is reckoned one of the oldest pieces of English sculpture extant, styles him "kinsman of the famous King Edward, alderman of all England, and the miraculous founder of this abbey." It was dedicated to St Dunstan, and its abbots were mitred, and sat in parliament; and so many kings of England were benefactors to it, that its yearly rents, says Camden, were 7000l. The town was then called *Ramsey the Rich*; but by the dissolution of the abbey it soon became poor, and even lost its market for many years, till about 185 years ago it recovered it. It is held on Saturday, and is reckoned one of the most plentiful and cheapest in England. In the year 1721 a great number of Roman coins was found here, supposed to have been hid by the monks on some incursion of the Danes. There is a charity school in the town for poor girls. W. Long. 0. 19. N. Lat. 52. 26.

RAMSEY, an island of south Wales, on the coast of Pembrokeshire, about two miles in length, and a mile and a half broad. Near it are several small ones, known by the name of the *bishop and his clerks*. It is four miles west of St David's, and 17 north-west of Milford haven. It belongs to the bishopric of St David's, and was in the last age, says Camden, famous for the death of one Justinian, a most holy man, who retiring hither from Britanny, in that age rich in saints, and devoting himself entirely to God, lived a long while in solitude, and being at last murdered by his servant was enrolled among the martyrs. W. Long. 5. 20. N. Lat. 51. 55.

RAMSEY, in the Isle of Man, to the north, a most noted and spacious haven, in which the greatest fleet may ride at anchor with safety enough from all winds but the north-east, and in that case they need not be embayed. This town standing upon a beach of loose sand, or shingle, is in danger, if not timely prevented, of being washed away by the sea.

RAMSGATE, a sea-port town of Kent, in the isle of Thanet, five miles from Margate, where a very fine pier has been lately built for the security of ships that come into the harbour, being seated near the Downs, between the north and south Foreland, 10 miles north-east of Canterbury. The town is situated in the cove of a chalky cliff. It was formerly but an obscure fishing village, but since the year 1688 has been improved and enlarged by a successful trade to Russia and the east country. But what renders it most worthy of notice, and attracts multitudes of strangers, is the new harbour, which is one of the most capacious in England, if not in Europe. It was begun in the year 1750, but delayed by various interruptions. It consists of two piers; that to the east is built wholly of Purbeck stone, and extends itself into the ocean near 800 feet before it forms an angle; its breadth on the top is 26 feet, including a strong parapet wall, which runs along the outside of it. The other to the west is constructed of wood as far as the low-water mark, but the rest is of stone. The angles, of which there are five in each pier, consist of 160 feet each, with octagons at the end of 60 feet diameter, leaving an entrance of 200 feet into the harbour, the depth of which admits of a gradual increase of 18 to 36 feet. E. Long. 1. 30. N. Lat. 51. 22.

RAMTRUT, a deity worshipped by the Ranazins of Hindostan, where he has a celebrated temple at Onor. He is represented as more resembling a monkey than a man.

RAMUS, in general, denotes a branch of any thing, as of a tree, an artery, &c. In the anatomy of plants it means the first or lateral branches, which go off from the petiolum, or middle rib of a leaf. The subdivisions of these are called *surculi*; and the final divisions into the most minute of all, are by some called *capillamenta*; but both kinds are generally denominated *surculus*.

RAMUS (Peter), was one of the most famous professors of the 16th century. He was born in Picardy in 1515. A thirst for learning prompted him to go to Paris when very young, and he was admitted a servant in the college of Navarre. Spending the day in waiting on his masters, and the greatest part of the night in study, he made such surprising progress, that, when he took his master of arts degree, he offered to maintain a quite opposite doctrine to that of Aristotle. This raised him many enemies; and the two first books he published, *Institutiones Dialecticæ*, and *Aristotelicæ Animadversiones*, occasioned great disturbances in the university of Paris: and the opposition against him was not a little heightened by his deserting the Romish religion, and professing that of the Reformed. Being thus forced to retire from Paris, he visited the universities of Germany, and received great honours wherever he came. He returned to France in 1571, and lost his life miserably in the horrid massacre of St Bartholomew's day. He was a great orator, a man of universal learning, and endowed with very fine moral qualities.

Ramus

ties. He publiſhed many books, which Teiſſier enumerates. Ramus's merit in his oppoſition to Ariſtotle, and his firmneſs in undermining his authority, is unqueſtionably great. But it has been doubted, and with much reaſon, whether he was equally ſucceſsful in his attempts after a new logical inſtitute. We have the following general outline of his plan in Dr Enfield's Hiſtory of Philoſophy. "Conſidering dialectics as the art of deducing concluſions from premiſes, he endeavours to improve this art, by uniting it with that of rhetoric. Of the ſeveral branches of rhetoric, he conſiders invention and diſpoſition as belonging equally to logic. Making Cicero his chief guide, he divides his treatiſe on dialectics into two parts, the firſt of which treats of the invention of arguments, the ſecond of judgments. Arguments he derives not only from what the Ariſtotelians call middle terms, but from any kind of propoſition, which, connected with another, may ſerve to prove any aſſertion. Of theſe he enumerates various kinds. Judgments he divides into axioms, or ſelf-evident propoſitions, and *dianoëa*, or deductions by means of a ſeries of arguments. Both theſe he divides into various claſſes; and illuſtrates the whole by examples from the ancient orators and poets.

"In the logic of Ramus, many things are borrowed from Ariſtotle, and only appear under new names; and many others are derived from other Grecian ſources, particularly from the dialogues of Plato, and the logic of the Stoics. The author has the merit of turning the art of reaſoning from the futile ſpeculations of the ſchools to forenſic and common uſe; but his plan is defective in confining the whole dialectic art to the ſingle object of diſputation, and in omitting many things, which reſpect the general culture of the underſtanding and the inveſtigation of truth. Notwithſtanding the defects of his ſyſtem, we cannot, however, ſubſcribe to the ſevere cenſure which has been paſſed upon Ramus by Lord Bacon and others; for much is, we think, due to him for having with ſo much firmneſs and perſeverance aſſerted the natural freedom of the human underſtanding. The logic of Ramus obtained great authority in the ſchools of Germany, Great Britain, Holland, and France; and long and violent conteſts aroſe between his followers and thoſe of the Stagyrite, till his fame vaniſhed before that of Deſcartes."

Ran.

RAN, in the old Engliſh writers, means open or public robbery, ſo manifeſt as not to be denied. Ran *dicitur aperta rapina quæ negari non poteſt.* Lamb. 125. Leg. Canut. cap. 58. Hence it is now commonly ſaid of one who takes the goods of another injuriouſly and violently, that he has taken or ſnatched all he could *rap* and *ran*.

RANA, or RANULA. See RANULA.

END OF THE FIFTEENTH VOLUME.

DIRECTIONS for placing the PLATES of Vol. XV.

Part I.

Plate		Page
Plate CCCXCIV.	to face	Page 6
CCCXCV.		
CCCXCVI.		
CCCXCVII.		32
CCCXCVIII.		76
CCCXCIX.		168
CCCC.		
CCCCI.		
CCCCII.		
CCCCIII.		
CCCCIV.		
CCCCV.		
CCCCVI.		
CCCCVII.		
CCCCVIII.		
CCCCIX.		
CCCCX.		272
CCCCXI.		350
CCCCXII.		371
CCCCXIII.		398

Part II.

Plate		Page
Plate CCCCXIV.	to face	Page
CCCCXV.		
CCCCXVI.		
CCCCXVII.		
CCCCXVIII.		
CCCCXIX.		
CCCCXX.		
CCCCXXI.		
CCCCXXII.		
CCCCXXIII.		
CCCCXXIV.		
CCCCXXV.		
CCCCXXVI.		
CCCCXXVII.		
CCCCXXVIII.		
CCCCXXIX.		
CCCCXXX.		
CCCCXXXI.		
CCCCXXXII.		
CCCCXXXIII.		
CCCCXXXIV.		